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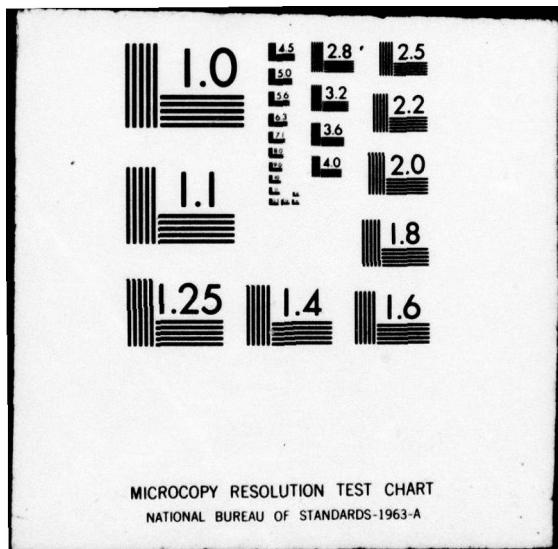


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# Evaluation of Planning for Fish & Wildlife

Okatibbee  
Lake Project  
February 1979



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Office of the Chief of Engineers  
Washington, D.C. 20314



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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The Okatibbee Lake Project is located on Okatibbee Creek near Meridian, Mississippi. At summer seasonal pool the lake covers 1,538 ha (3,800 ac). Lands acquired in fee surrounding the summer pool totals 2,895 ha (7,155 ac). Approximately 2,024 ha (5,000 ac) have been licensed to the Mississippi Game and Fish Commission (MGFC) for the purpose of wildlife management.		
A smaller project was proposed earlier with flood control and water supply as the only primary project purposes. Acquisition in fee (continued next page)		

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*CONT*

was planned to include only the area expected to be inundated by the five-year flood pool, approximately 2,428 ha (6,000 ac). The CE's survey report was submitted to Congress some 14 days before release of the FWS's report which was dated January 12, 1962.

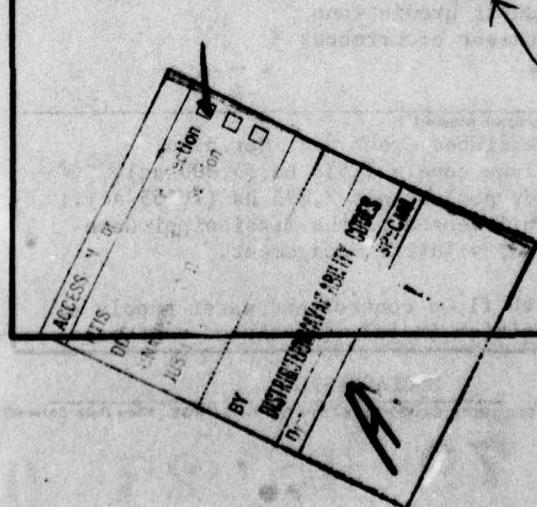
The 1962 report of the FWS recommended acquisition and state management of approximately 1,133 ha (2,800 ac) located above the five-year flood pool, and additional water storage to permit flow releases for dilution of downstream pollution, as had already been recommended by the Public Health Service.

The CE redesigned the Okatibbee project to include a seasonal (summer) water quality pool of  $1.6 \times 10^7 \text{ m}^3$  (12,900 ac ft) and the acquisition in fee of 4,433 ha (10,955 ac) of land and water.

In their updated fish and wildlife planning report (August 17, 1964), the FWS reiterated their earlier request to permit the MGFC to manage selected project lands for wildlife purposes. They also recommended the development and implementation of a reservoir-use zoning plan, provision of access to the tailwater, and construction and operation of the project to meet the criterion for sustaining a desirable warm-water fish population. No quantitative projections of natural resource abundance or use of such resources were contained in the 1964 report. The 1962 predictions were reaffirmed without elaboration in the 1964 report. Therefore, this evaluation has relied of necessity upon the earlier 1962 presentations. The additional land planned for acquisition in fee was expected to mitigate the resources lost by habitat inundation.

The small game hunting projection of 2,500 hunter-days was almost identical to the current use level of 2,473 hunter-days. The post-construction deer population on project lands is equal to the estimated pre-construction herd. As a result of special hunting restrictions, big game hunting (75 hunter-days) is considerably below the level expected to have been provided by the present time (425 hunter-days). Waterfowl hunting effort (356 hunter-days) is slightly less than one-half the predicted level (790 hunter-days). Development of the project for waterfowl has been handicapped by the inability to construct sub-impoundment habitat. Waterfowl production is probably double the project-associated harvest.

Current angling use of Okatibbee Lake is estimated at 40,600 annual trips, compared with the predicted 60,000 angler-trips. The tailrace fishery supports approximately double the 7,000 angler-trips predicted prior to project construction. Striped bass have been successfully introduced in Okatibbee Lake. Although Okatibbee Lake releases are not believed to have resulted in direct fish kills, the discharge is low in dissolved oxygen during periods of lake stratification; chemical constituents of the outflow are believed responsible for oxygen sags observed downstream.



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STUDY TO EVALUATE THE ADEQUACY AND  
PREDICTIVE VALUE OF FISH AND WILDLIFE  
PLANNING RECOMMENDATIONS AT CORPS  
OF ENGINEERS RESERVOIR PROJECTS

PHASE II  
INDIVIDUAL RESERVOIR PROJECT EVALUATION REPORTS

THE OKATIBBEE LAKE PROJECT

Conducted for Office, Chief of Engineers, U.S. Army

By Sport Fishing Institute, Washington, D.C.

Under Contract No. DACH73-74-C-0040

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**PREFACE**

This document was prepared by staff of the Sport Fishing Institute for the U.S. Army Corps of Engineers (CE) under contract number DACW73-74-C-0040. The contract required the compilation and comparison of pre- and post-construction data treating fish, wildlife, or both fish and wildlife (depending upon data availability) for twenty separate CE water development projects. This report presents the findings for one of the twenty individual project evaluations.

Upon completion of the full series of twenty separate studies, a final report will be prepared which will contain an analysis of the validity of the predictive procedures used in fish and wildlife planning, and will contain recommendations for improving the planning process.

Evaluation of the fish and wildlife resources of the Okatibbee Lake project would not have been possible without the assistance and cooperation of many individuals. Mississippi Game and Fish Commission personnel including Messrs. Edsel Cliburn, Dan Cotton, Jack Herring, John Shirley and Lowry Townsend provided most of the resource inventory and recreational use data reported. Mr. John Hester and Mr. Charles Jones with the U.S. Fish and Wildlife Service in Decatur, Alabama, provided access to project documents and supplied informative insites regarding continuing efforts to avoid wildlife losses below the Okatibbee project. Mr. Bill Pennington of the U.S. Army Corps of Engineers assisted with the field reconnaissance trip and supplied certain key information. Mr. Chester McConnell, Southeast Field Representative, Wildlife Management Institute, participated in

the field investigation and reviewed and strengthened the wildlife-related (non-fish) section of the final manuscript.

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**Map of Okatibbee Lake project.**

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**SPORT FISHING INSTITUTE**

**PROJECT PERSONNEL**

**Norville Prosser (Assistant Project Leader)**

**Robert Martin (Project Leader)**

**Richard Stroud (Contractor's Representative)**

**Mary Burroughs (Project Secretary)**

**CONSULTANT'S REVIEW**

Professional terrestrial wildlife consultative services were provided by the staff of the Wildlife Management Institute (WMI). Project personnel were accompanied by a WMI staff specialist during field reconnaissance and on on-site discussions. The terrestrial wildlife portion of the prepared evaluative manuscript was reviewed and evaluated by WMI. All pertinent suggestions offered by the consultant are reflected in this report.

INDIVIDUAL RESERVOIR PROJECT EVALUATION REPORTS

OKATIBBEE LAKE PROJECT

INTRODUCTION

Location

Okatibbee Lake is located in Mississippi on Okatibbee Creek, a tributary of the Pascagoula River. The dam is in Lauderdale County, about 11 km (7 mi) northwest of Meridian. At normal pool, the entire lake is confined to Lauderdale County. An estimated 67,087 people resided in the county in 1970. Mississippi Highway No. 19 passes within one mile of the lake and Lauderdale County Road No. 2 crosses the upper end (Figure 1).

Authorization

The Okatibbee Lake project was authorized by the Flood Control Act of 1962 (Public Law 87-874) in response to a Corps of Engineers' survey report submitted to Congress on December 29, 1961 (1). The project was constructed to provide flood control, water quality control, water supply and recreation benefits. Okatibbee was the first such project in the southeast to include storage for water quality control (2).

Physical Features

Construction began on Okatibbee in June, 1965, and filling of the lake began on November 26, 1968. The project was essentially complete at dedication on May 30, 1969. Okatibbee Dam is 1,993 m (6,538 ft) long. Pertinent physical data for the project are presented in Table 1 (3). The 1,538 ha (3,800 ac) normal summer pool is 9.7 km (6 mi) long and has a 45 km (28 mi) shoreline. The total project includes 4,433 ha (10,955 ac), of which

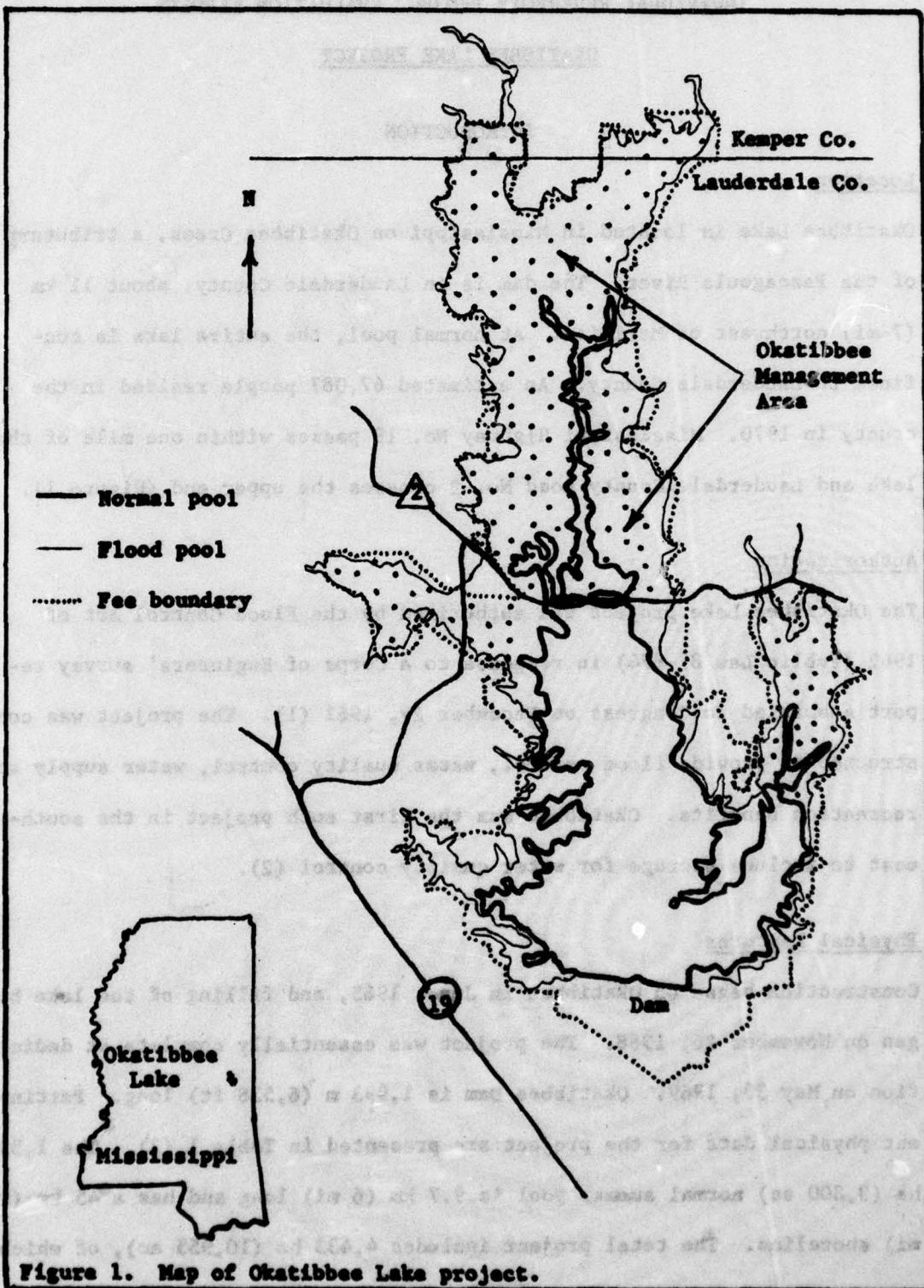


Figure 1. Map of Okatibbee Lake project.

Table 1. -- Pertinent physical data for Okatibbee Lake project

Reservoir	Elevations (feet)		Area ha	Area (ac)	Storage capacity $\text{m}^3$ (ac-ft)
	m	ft			
Maximum pool, spillway design flood	111.2	(364.8)	4,371	(10,800)	$2.47 \times 10^8 \text{ m}^3$ (200,000)
Maximum pool, standard project flood	109.4	(358.8)	3,561	(8,800)	$1.76 \times 10^8 \text{ m}^3$ (142,400)
Top of secondary flood control pool	107.3	(352)	2,671	(6,600)	$1.09 \times 10^8 \text{ m}^3$ (88,600)
Top of primary flood control pool	106.4	(349)	2,266	(5,600)	$0.87 \times 10^8 \text{ m}^3$ (70,300)
Top of normal operating pool	104.5	(343)	1,538	(3,800)	$0.52 \times 10^8 \text{ m}^3$ (42,100)
Summer	103.3	(339)	1,093	(2,700)	$0.36 \times 10^8 \text{ m}^3$ (29,200)
Winter					
Bottom of water quality control pool	100.0	(328)	526	(1,300)	$0.10 \times 10^8 \text{ m}^3$ (7,800)
Stream bed	92.5	(303.5)	--	--	--
Normal tailwater	94.2	(309)	--	--	--
Top of spillway crest	109.4	(359)	3,561	(8,800)	$1.76 \times 10^8 \text{ m}^3$ (142,400)

872 ha (2,154 ac) are above the guide take line at elevation 109.7 m (360 ft) msl or 91.4 m (300 ft) horizontal from elevation 108.2 m (355 ft) whichever was greater. The guide taking line was used to determine the approximate extent of fee purchase. Deviations occur because of the alignment of property lines and the need to purchase acreage for recreational areas. Approximately 2,024 ha (5,000 ac) of the project have been licensed to the Mississippi Game and Fish Commission to manage as a wildlife area. Water is drawn from the lake at elevation 94.5 m (310 ft) msl or 10 m (33 ft) below the surface at normal summer pool.

#### Area Description

Okatibbee Creek is entrenched in a fairly deep broad valley which is bordered by ridges and hills. Soils of the basin consist of silty clays, sandy clays, and silty sands. Land use within the Okatibbee drainage basin consists of 75 percent woodland, 10 percent pastureland, 10 percent cropland, with the remainder residential. Industrial development in the Okatibbee Lake area is concentrated in and around the City of Meridian (2). Average annual rainfall for the area over the period 1921-1950 was 140 cm (55 in).

#### Descriptive Reports

Formal reports and copies of pertinent correspondence were obtained at several locations. Pre-impoundment and post-impoundment data were obtained at the Fish and Wildlife Service (FWS) field office for Ecological Services in Decatur, Alabama, and at the FWS Regional Office in Atlanta. The Mobile District Office, Army Corps of Engineers (CE), provided several key documents. Post-impoundment data were provided by staff members of the

Mississippi Game and Fish Commission (MGFC) and the Okatibbee Lake Project Manager (CE).

On May 17, 1961, the District Engineer requested FWS comments on the Okatibbee project, to be received by August, 1961. The FWS was unable to complete their report by August, but submitted a draft report to the CE on December 29, 1961. The CE submitted their survey report on the same date, December 29, 1961. The final edition of the FWS report was released on January 12, 1962 (4). Intermittant exchanges of information continued between these two agencies through 1962 and 1963. During this period, the CE modified the Okatibbee project design to incorporate storage for pollution abatement as a project purpose, and to increase, correspondingly, the maximum flood pool storage elevation. These changes were described in the CE's General Design Memorandum which was approved July 17, 1964 (5).

The FWS responded to the flood pool and seasonal pool enlargements in their updated report released on August 17, 1964 (6). Further contacts between the agencies addressed the project lands to be licensed to the MGFC. The CE's Preliminary Master Plan was completed on April 2, 1965. This CE document addressed the 1962 recommendations of the FWS. About 2,143 ha (5,296 ac) of land and water were licensed to the MGFC for fish and wildlife management purposes in September of 1969.

In April, 1975, the CE released an environmental statement on the operation and maintenance of Okatibbee Lake (3). The FWS prepared a follow-up report on their earlier planning reports in 1976 (7).

## **WILDLIFE RESULTS AND DISCUSSION**

### **Wildlife Resources -- General Comments**

The FWS supplied formal letter-reports containing fish and wildlife planning recommendations on two occasions. The more definitive and quantitative impact assessment data were contained in the first report which was released January 12, 1962. Subsequently, the project design was altered by the construction agency to incorporate storage for downstream water quality releases.

This alteration necessitated increasing the elevation of the flood storage pool by four additional feet to accommodate water quality storage. In 1964, the FWS responded to these project changes with an updated report. This new report contained no updated quantitative wildlife impact data; rather, it relied by reference on the data contained in the earlier (1962) report, stating: "Latest field reconnaissance confirms the evaluation given in that [1962] report."

The various storage pools (elevations and surface areas) anticipated during preparation of the two FWS reports are described in Table 2, together with the actual project dimensions.

The following pre-project fish and wildlife descriptions and predicted impacts relied, for the most part, on the quantitative materials contained in the 1962 report, later reaffirmed by the 1964 report as already noted.

### **Wildlife Resources -- Pre-impoundment Predictions**

The existing conditions for wildlife prior to project construction were

Table 2 -- Okatibbee Project features; elevations and areas inspected as envisioned by fish and wildlife planners at the time of preparation of major planning reports

Project feature	Elevation			Area		
	1962 ft	1964 ft	Actual ft	1962 ac	1964 ac	Actual ac
Normal flood pool	108.2 (335.0)	109.4 (359.0)	109.4 (359.0)	3,035 (7,500)	3,561 (8,800)	3,561 (8,800)
Flood storage pool (100 year frequency)	--	--	107.3 (352.0)	--	--	2,671 (6,600)
Seasonal pool (April to December)	103.3 (339.0)	104.5 (343.0)	104.5 (343.0)	1,133 (2,800)	1,538 (3,800)	1,538 (3,800)
Seasonal pool (December to March)	103.3 (339.0)	103.3 (339.0)	103.3 (339.0)	1,133 (2,800)	1,093 (2,700)	1,101 (2,720)
Minimum pool	102.3 (335.5)	102.3 (335.5)	100.0 (328.0)	931 (2,300)	890 (2,200)	518 (1,200)
Lands acquired in fee (Outside contour)	106.7 (350.0)	109.1 (358.0)	109.7 (360.0)	2,428 (6,000)*	4,413 (10,905)	4,436 (10,960)

\* Flottage easements were planned for lands between elevations 350 and 360 comprising about 3,200 acres in 1962 which would have involved approximately 9,200 acres total.

summarized in the 1962 report. This brief three-paragraph discussion is as follows:

The area evaluated for wildlife resources and utilization includes the land area affected by the dam site, the maximum flood pool, and a perimeter zone surrounding the flood pool. A total of about 10,000 acres is involved.

Within the evaluated area habitat quality for woodland game, waterfowl, and furbearers is high. The flood plain varies from one to three miles in width and is forested with a dense growth of mast-producing bottomland hardwoods. A deer herd has been established and wild turkey are being stocked. Squirrels and rabbits are the principal upland game species hunted, and bobwhite quail are found in the occasional open areas and surrounding woodlands. Raccoons, fox, and opossum are hunted for sport. Principal furbearers are mink and beaver. The many beaver ponds in the flatwoods provide waterfowl shooting. Wood ducks nest in the area.

The area is heavily utilized by hunters and it is estimated that for the 50-year period the 10,000 acres evaluated would provide about 6,700 hunter-trips annually, valued at \$17,000.

The monetary expressions of non-commercial use of fish and wildlife resources were based on the "Interim Schedule of Values for Recreational Aspects of Fish and Wildlife," adopted by the Inter-Agency Committee on Water Resources (8).

Construction of the Okatibbee project without acquisition of additional project lands was expected to cause a net loss of wildlife habitat and wildlife-oriented recreational opportunity (i.e., hunting), discussed in the 1962 report as follows:

Of the 10,000 acres of wildlife habitat analyzed, 2,800 acres would be permanently inundated at water supply pool elevation. The remainder of the 7,500-acre flood pool (4,700 acres) would be subject to periodic inundation. An additional 2,500 acres, generally located on the lower perimeter of the reservoir, would be affected. This would constitute a total loss of 2,800 acres of terrestrial habitat through permanent flooding, a reduction in value of habitat and utilization on 4,700 acres through per-

iodic flooding, and a total loss of availability of resource utilization on 2,500 acres through development of parks, camp sites, and other installations not compatible with wildlife management. It is estimated that with-project conditions the remaining lands would support about 2,800 hunter-trips annually. Thus a loss of 3,900 hunter-trips would result from development of the project.

Waterfowl would be benefitted. Although there would be a loss of woodland feeding habitat, the water area would provide an expanse of nesting [resting] habitat not now available. Waterfowl utilization of the area has been increasing since the establishment of Noxubee National Wildlife Refuge about 45 air miles north of the dam site. Stopover of migration flights has undoubtedly been restricted by the absence of sizeable water areas. Project-created incidental benefits resulting from waterfowl usage are estimated at about 900 hunter-trips annually, which are included in the with-project total of 2,800 trips.

The 1962 FWS report contained three recommended actions to avoid or compensate for the expected adverse impacts of the Okatibbee project on fish and wildlife. One of the recommendations was specific to fisheries, one generally recommended adequate access facilities be provided, and one was specific to wildlife. This latter recommendation, for mitigation of wildlife-related impacts, was as follows:

Land Acquisition for Wildlife Management. Tentative project plans call for acquisition of all land below elevation 350 feet in fee. Flowage easement would be taken on lands between elevations 360 and 350 comprising about 3,200 acres. With flood pool lands remaining in private ownership, public benefits from remaining big and upland game populations and from increased waterfowl usage would be limited to the degree of public access permitted by the landowners.

To mitigate project-occasioned wildlife losses and to insure maximum public benefits, it is proposed that all lands up to elevation 360 feet within the boundary shown on Plate 1 be acquired in fee. This would entail fee purchase instead of easement on about 2,500 acres plus about 300 acres to "block in" the 360 foot contour. Difference in cost to the project is estimated at about \$125,000.

Following acquisition, those lands lying within the proposed waterfowl management area should be made available to the Mis-

Mississippi Game and Fish Commission for development, operation, and maintenance in accordance with a general plan formulated pursuant to Sections 3 and 4 of the Fish and Wildlife Coordination Act. Implementation of this proposal would provide an estimated use of about 3,500 additional hunter-trips within the management area.

The Mississippi Game and Fish Commission, during regular session of October 11, 1961, adopted a motion to accept responsibility for the development, operation and maintenance of those lands, if acquired. This action would assure maximum public utilization of wildlife resources throughout the life of the project.

These FWS recommendations were formally submitted to the Chief of Engineers by the Assistant Secretary of Interior in a letter dated July 6, 1962 (9). The pertinent statement in the Assistant Secretary's letter was as follows:

It is recommended that your report be modified to include a recommendation that detailed fish and wildlife studies be made by the Bureau of Sport Fisheries and Wildlife and the State of Mississippi Game and Fish Commission after project authorization, and that authorization be given for the acquisition of land for fish and wildlife purposes and for modification of the project plan to include measures for the cooperation and development of fish and wildlife resources in accordance with a plan which may be agreed to by the Chief of Engineers, the Director of the Bureau of Sport Fisheries and Wildlife and the Executive Director of the state of Mississippi Game and Fish Commissioners. These measures recommended in the Bureau of Sport Fisheries and Wildlife report of January 12, would be included in the studies and plans developed after project authorization. A copy of the report is enclosed and it is requested that it be included with your report when it is transmitted to Congress.

Concurrently, the Public Health Service had requested provision of additional storage at Okatibbee for the purpose of augmenting flows in Okatibbee Creek in order to ameliorate water quality problems. The construction agency redesigned the project to include water quality as a project purpose. The basic impact of this decision on storage levels was described

in the updated FWS planning report which was submitted on August 17, 1964  
(6), viz:

As affecting the fish and wildlife resources of the area, principal departure from original planning is provision of 4 additional feet of storage on a seasonal basis (April to December). This pool will be stored above the maximum water supply pool between elevations 339 and 343, and will enable downstream water-quality control. This project purpose was recommended in our prior report.

The CE modified the land acquisition plan for the project in order to accommodate this additional water storage. The modified acquisition plan also reflected terms of the recently enacted joint policies of the Departments of the Interior and the Army relative to reservoir project lands (10).

A description of these new land acquisition plans was summarized in the 1964 report of the FWS as follows:

The guideline for fee acquisition of lands has been established at the blockout of the 358-foot contour while maintaining at least a 300-foot horizontal clearance from the 100-year frequency flood pool at elevation 352. A total area of about 10,905 acres will be acquired in fee, of which 9,405 acres will be for the reservoir and 1,500 acres for public use and access. An additional 1,085 acres will be acquired in perpetual easements in remote areas of the reservoir. Reservoir lands will be cleared to the top of the seasonal pool (elevation 343 feet, 3,800 acres).

Our previous report recommended that project lands be acquired in fee title to elevation 360 feet and portions of these lands be made available to the Mississippi Game and Fish Commission for development and management for fish and wildlife purposes. It is our opinion that the presently proposed guideline for fee acquisition will make possible the fulfillment of that recommendation.

Predicted impacts of the additional storage on resident and migratory wildlife were summarized as follows (emphasis added):

Addition of the seasonal pool and inundation of 1,100 more ac-

res will cause additional upland game habitat losses. It is our opinion, however, that by intensive development and management of project lands by the Mississippi Game and Fish Commission wildlife losses will be mitigated.

During wet years, or years in which the water level can be held near 343 feet, the reservoir will provide waterfowl hunting. As stated in our prior report, the reservoir will furnish resting habitat for migratory waterfowl, a requirement now lacking in the region, but will not produce waterfowl foods and will therefore be only lightly used unless food plantings are developed on peripheral project lands.

To assure the maximum development of fish and wildlife, the 1964 report of the FWS contained four recommendations, two of which related to wildlife-associated recreation, viz:

1. That suitable portions of the project lands planned for fee acquisition be made available to the Mississippi Game and Fish Commission for development and management of fish and wildlife as recommended in our previous report and in accordance with a general plan formulated pursuant to Sections 3 and 4 of the Fish and Wildlife Coordination Act.
2. That a reservoir zoning plan be developed and implemented to provide adequately for all uses.

The MGFC reviewed the 1964 FWS report and provided a one sentence response which simply advised that the State had "no comment" (11).

The statement, emphasized above, that "...by intensive development and management of project lands by the Mississippi Game and Fish Commission wildlife losses will be mitigated," would indicate that the expected post-impoundment conditions for resident (non-migratory) wildlife would approximate the previously-described without-project conditions (FWS report of 1962) provided the MGFC undertook intensive development for wildlife of project lands located above the seasonal pool.

The FWS report of 1962 expressed pre-project wildlife conditions and post-construction impact predictions exclusively in terms of angler-day and hunter-day values. The report did not discuss probable project impacts in terms of wildlife communities. However, handwritten notes and calculations related to the project discovered on file in the Decatur Field Office of the FWS Division of Ecological Services indicated some recognition of the impacts on wildlife populations anticipated as a result of the Okatibbee project. These computations were undertaken by FWS personnel during preparation of their 1962 report.

Table 3 summarizes the pre-construction wildlife population, hunting effort and harvest information which was contained in the unpublished FWS notes on file in Decatur, Alabama. It is apparent that pre-project population estimates were available only for deer, turkeys, squirrels, rabbits, and quail. Harvest estimates were available only for deer and ducks.

The hunting data for the Okatibbee project area, absent the project, were calculated as follows: First, the current number of licensed hunters, categorized by major hunting type (big game, small game, waterfowl) that hunted in the 4,847 ha (10,000 ac) project area, was increased to accommodate a projected four percent annual increase over the 50-year evaluation period assumed by the FWS. The resulting average annual number of hunters for each group, i.e., 212, 153, and 451 for waterfowl, big game (deer), and small game, respectively, were then expanded by the estimated number of annual trips per hunter. These estimates (6.7 waterfowl trips, 5.0 deer trips and 10.0 small game trips), resulted in the total hunting

Table 3. -- Wildlife population, harvest and hunting effort data within 10,000 acre area of project influence as assumed by FWS for Oglala Sioux project area without the project; from 1962 FWS basic data

Species	Estimated populations	Pre-construction harvest	Hunting effort (hunter-days)
Deer	100	12	765
Turkey	20-30	--	--
Squirrel	2,500-3,000	4,510	1.
Rabbit	5,000	1.	1.
Coues	600	1.	1.
Prairie dogs	---	500+	1,420
Duck	Many	--	--
Beaver	Many	--	--
Opossum	Many	--	--
Bear	Many	--	--
Wolf	Many	--	--

1. Combined annual game hunting effort

effort estimates shown in Table 3.

Several pages of the unpublished basic data reflect calculated post-impoundment (with-project) hunting-effort values that are considerably higher than those contained in the 1962 report. The figures apparently were calculated to reflect the additional land acquisition noted in the 1964 report. These unpublished basic data indicated an expected total annual use of 9,050 hunter-days which included 5,000, 4,000 and 50 hunter-days for upland game, waterfowl, and big-game hunting, respectively (assuming appropriate management). However, these increased estimates of use were never transmitted to the construction agency. Instead, the FWS simply indicated in the 1 report (1964) that, under the proposed development plan, the "loss will be mitigated." Therefore, the without-project conditions as described in the formal 1962 report and associated supporting data are assumed to be the appropriate "with-project" projections.

Expanding the pre-impoundment hunting levels for the 4,047 ha (10,000 ac) project site by four percent each year for 25 years (mid-point of 50 year evaluation period) produced the reported average anticipated hunting figure of 6,700 hunter-days annually. As Okatibbee was completed in 1968, only 10 years have elapsed between inundation and the present. Therefore, it was necessary to recalculate the projected hunter-day figures to reflect a four percent increase each year for a period of only 10 years. These computations resulted in hunter-use figures for 1978 of 3,715 hunter-days (total) comprised of 2,500 hunter-days for small game, 790 hunter days for waterfowl and 425 hunter-days for deer.

Subsequent to the release by the FWS of their August 17, 1964, planning report, several interesting communiqus were exchanged regarding the transferal of additional project lands under license to the MGFC. These discussions related to the 202 ha (500 ac) Bales Creek arm, an area currently included in the MGFC's management area. The CE proposed that this area be added to the already agreed smaller management area. The MGFC was cautious, however, as revealed in the following excerpt from an FWS trip report of March 30, 1965 (12):

March 24. -- After talking by phone with Massrs. Smith (Regional Office) and Horne (Mobile Corps of Engineers) about Okatibbee lands, I proceeded to Meridian and contacted Mr. Howard Beeland (Miss. Game and Fish Commission) and Mr. Mason (Corps of Engineers) and discussed the area under consideration. Maps of the area were borrowed from Corps and field inspections were made. Mr. Horne informed me Corps planned to acquire all lands of the project in fee and they felt the area should be included in our proposed wildlife management area. He said additional justification was not needed. I called Mr. Turcotte on Corps' proposal and tentatively he favored it. His reservation was that he did not want the Commission to be caught in the "middle" as the agency recommending or supporting fee acquisition if landowners were in opposition. I informed him I understood that Corps planned fee acquisition for entire area except in small, isolated spots and they thought the best use of the area would be for fish and wildlife.

The concerns expressed were adequately ameliorated and MGFC agreement to manage this additional acreage was expressed by letter dated June 10, 1965 (13).

#### Wildlife Resources -- Post-impoundment Occurrences

The CE's land acquisition guideline for the Okatibbee project was established at elevation 109.7 m (360 ft) msl. That elevation was blocked out in accordance with the joint acquisition policies of the Department of the Army and the Department of the Interior in order to maintain a 91.4 m (300

ft) horizontal clearance from the 108.2 m (355 ft) msl reservoir design flood control pool (14). The total area acquired for the project was 4,433 ha (10,955 ac) of which 872 ha (2,154 ac) were above the guide taking line (3). At the summer pool elevation, 104.5 m (343 ft) msl, the lake covers 1,538 ha (3,800 ac). An area of 2,015 ha (4,980 ac) of the 3,033 ha (7,494 ac) of land above normal pool were licensed to the MGFC for game management purposes effective 1 October 1969. The total area under license to the MGFC, including water area, is 2,143 ha (5,296 ac).

Since acquiring the license to manage the 2,143 ha (5,296 ac) Okatibbee Wildlife Management Area, the MGFC has budgeted up to \$35,000 per year for development, operation and maintenance of the area. The management goals for the Okatibbee Wildlife Management Area listed by the MGFC are as follows (15):

- 1) Attract and hold a huntable population of ducks and geese.
- 2) Provide hunting and improve the habitat of native wildlife species.
- 3) Develop public dove shooting fields.
- 4) Encourage use of the area and other esthetic observances.
- 5) Increase production of wood ducks by erecting and maintaining nesting boxes.

Management activities which have been undertaken to reach these goals, as reflected in the eight consecutive annual work plans for 1970-71 to 1977-78 (16-23), include the construction of a combination equipment and storage building. Later, this facility was enlarged and fenced. The approximate total cost of this facility, exclusive of maintenance, was \$8,400. In 1972-73 the MGFC began construction of a system of levees on the lic-

ensed lands to create shallow sub-impoundment habitat for waterfowl management purposes. A total of 1,524 m (5,000 ft) of levees have been completed to date (Edsel Cliburn, pers. comm., 1979). This is considerably less than desired by the MGFC. Problems with water levels which were too high to allow use of heavy equipment, and equipment costs have prevented completion of the planned sub-impoundment system.

Other major land manipulation practices designed to benefit wildlife on the Okatibbee Wildlife Management Area have included sharecropping, beaver pond management, prescribed burning, and herbaceous plantings. Access facilities in the form of bridges, roads, and hunter access lanes have been built or improved.

A total of 22 vegetative types were described on the 3,033 ha (7,494 ac) of CE lands at the Okatibbee project (24). These data were used to prepare Table 4 which reflects the circumstance that over half of the Okatibbee project lands are currently comprised of bottomland hardwood and swamp habitat (61.2 percent).

The wildlife resources of the Okatibbee drainage basin are highly rated by the MGFC (25). The Okatibbee project lands also support important wildlife resources. Unfortunately, no systematic sampling of users or of wildlife populations is being carried out either on licensed project lands or on unlicensed project lands. Several individuals have working knowledge of the wildlife resources at Okatibbee, gained from several years of continuous daily management activity on project lands. The professionally-rendered estimates of animal population densities and wildlife utilization

**Table 4 . -- Vegetative types and area of each type for Okefenokee Lake project lands**

Stand type	Area		Percent of total
	Ha	(Ac)	
Old field succession	314	(775)	10.3
Bottomland hardwood	1,334	(3,297)	44.0
Pine	267	(659)	8.8
Pine-hardwood	270	(666)	8.9
Pine-plantation	33	(83)	1.1
Operational area	205	(506)	6.8
Cultivation	72	(179)	2.4
Pasture	16	(40)	0.5
Swamp	522	(1,289)	17.2
<b>Total</b>	<b>3,033</b>	<b>(7,494)</b>	<b>100.0</b>

provided by these professional wildlife managers constitute the available post-impoundment record of project-associated wildlife resources. These individuals include Edsel Cliburn, Dan Cotton, and Lowry Townsend with the MGFC and Bill Pennington with the CE. A summary of the utilization and harvest data made available by these professionals for this evaluation is presented in Table 5.

Big game species at Okatibbee include both white-tailed deer and turkey. The resident deer herd is estimated at 100 to 120 head. Deer hunting on the OWMA is limited to primitive fire arms and bow hunting. As a result of these restrictions, annual hunting effort (75 hunter-days) and harvest (one to two deer) are severely limited. Turkey hunting is prohibited on project lands, which are believed to support from two to four flocks. Additional observations made by management personnel with regard to big game at the Okatibbee project related to the refuge-associated contribution of the project for both deer and turkey populations and hunting effort off project lands. Many project-associated deer are believed to be harvested by people hunting on lands along the periphery of the Okatibbee project. Also, the OWMA may possibly be contributing to an expansion of the wild turkey population beyond the actual confines of project lands. These postulated contributions have not been documented to date.

It should be noted that the state game management staff expressed on several occasions, during, and subsequent to the investigator's familiarization field trip, that the limited access to major portions of the OWMA effectively reduces utilization of many wildlife populations which occur on this area. The FWS is familiar with this problem, having summarized the

Table 3. -- Estimated hunting effort, harvest and success rates for licensed lands (OMA) and unlicensed lands (GE) at the Okatibee Lake project in Mississippi

Species	Hunting-days				Harvest				Average daily bag			
	OMA		GE		OMA		GE		OMA		GE	
	1975-76	1976-77	1977-78	Avg.	1975-76	1976-77	1977-78	Avg.	1975-76	1976-77	1977-78	Avg.
Squirrel	678	690	712	693	297	990	2,576	2,415	2,612	2,534	1,099	3,633
Habits	365	374	365	375	375	750	1,375	1,421	1,540	1,445	1,445	2,890
Dove	260	265	273	266	7	266	1,300	1,272	1,375	1,316	7	1,316
Quail	213	218	225	219	94	313	383	349	650	394	169	563
Woodcock	208	213	220	216	162	356	374	361	357	357	261	598
Pheasants	72	76	80	77	77	154	158	156	160	158	158	316
Bear	44	67	40	50	25	75	1	1	None	0.7	1	1.7
Turkey	None	None	None	None	None	None	None	None	None	None	None	None

1) Okatibee Wildlife Management Area data provided by resident game manager and area wildlife biologist with MFC

2) Average contributions from non-licensed GE lands approximated by state wildlife managers and GE project personnel during field reconnaissance and discussions

3) Average daily bag data provided for OMA were applied to hunting effort on non-licensed land as estimated above

access situation as follows (25):

Access to the wildlife management area is a problem. The main area is bordered primarily by private holdings and, as such, is accessible only by a long walk. This effectively prevents much higher utilization by area hunters.

It is believed that the local rabbit population may have benefitted as a result of project construction. Several acres of herbaceous seedings, share cropping, and other farming activities have produced conditions more favorable to rabbits than the predominantly timber and pasture land conditions extant prior to project construction. It is estimated that 2,890 rabbits are harvested annually by hunters during 750 hunter-days of effort.

There are more squirrels per unit of remaining squirrel habitat than prior to project construction. This is due to better law enforcement on project lands. The project-caused loss of squirrels was in direct proportion to the loss of timbered lands. It was estimated that approximately 1,230 ha (3,040 ac) of bottomland timber was flooded (or cleared) by the 1,538 ha (3,800 ac) summer pool. It is currently estimated that 990 hunter-days of project-associated squirrel hunting, annually, result in a harvest of 3,633 animals.

Dove management has been confined to the CWMA where 30 ha (75 ac) have been planted and are managed as dove hunting fields. One-quarter of the share-cropped corn fields on the CWMA are left standing and doves also utilize these areas for feeding. The resulting hunting effort, approximately 270 hunter-days per year, is confined almost totally to the state-managed CWMA. An average of 1,316 doves have been harvested, annually.

Herbaceous plantings on three small areas and a limited amount of controlled burning on 20 ha (50 ac), and farming operations have benefitted the Okatibbee quail population. An estimated 313 hunter-days are expended annually with a resulting harvest of 563 quail on Okatibbee project lands.

The project is believed to have benefitted raccoon and muskrat. Beaver may not have been benefitted; however, the active beaver colonies in the upper end of the project have created ecological modifications which have proven advantageous to other wildlife. The MGFC stocked 21 alligators in 1972-73 in the beaver ponds, partially to control the beaver population within the upper reservoir area.

Fox hunting and raccoon hunting total an average of 154 hunter-days, with resultant harvests approximating 320 animals annually. Four trappers who normally work the Okatibbee project lands harvest annually an estimated average of 100 raccoon, 50 beaver, 3 bobcat, 50 opossum, 20 fox, 50 muskrats, and an occasional mink and otter.

Water management has proven to be the most important obstacle to optimum waterfowl management at the Okatibbee Lake project. Both development and management activities have been handicapped by inadequate availability of water storage for this purpose. Attraction of migratory waterfowl to the project is the MGFC's primary management goal for Okatibbee. Therefore, this limitation is of great importance to the MGFC program. A brief summary of the problems and potential water level management plan was presented by the FWS in their follow-up report on Okatibbee, viz (7):

Reservoir operational criteria prescribes maintenance of a conservation pool at elevation 343 (3,800 acres) from May through

October, dependent upon inflows and withdrawals for downstream water quality needs. During the month of November the conservation pool is lowered four feet to elevation 339 (2,720 acres). Most of the resultant dewatered mud flats (1,080 acres) occur in the upper reaches of the reservoir in the wildlife management area. This drawdown occurs too late in the growing season for establishment of vegetative growth which could be of benefit to wildlife, particularly migrant waterfowl. An earlier drawdown would permit some management opportunities to increase reservoir utilization by waterfowl. The large drawdown in October 1973 in connection with gizzard shad control resulted in luxuriant vegetative growth in most dewatered areas of the reservoir. While earlier drawdowns may conflict with other uses such as swimming, it is felt this conflict would not be of a severe nature if drawdowns were initiated in September coincident with reopening of public schools.

According to a MGFC biologist, the Okatibbee project is the most heavily hunted public waterfowl area in the area (Edsel Cliburn, pers. comm., 1978). The estimated harvest and effort data provided for this evaluation reflected a total project-related waterfowl harvest of approximately 600 birds in the course of 356 hunter-days, annually. Most of the waterfowl harvested are ducks. The maximum annual harvest of geese at the project was placed at approximately 30 birds in 1973-1974 (following the drawdown for selective control of shad for fish management purposes). Unfortunately, few data were located to document the actual use of Okatibbee by migratory waterfowl. The limited data of this nature acquired by the MGFC proved to be non-retrievable at the time of this investigation. The only located referenced estimate of migratory waterfowl usage was contained in the CE's environmental impact statement (3), vis:

The waterfowl population total for 1971 was estimated at 20,000 with a season take of 400 which included mallard, scaup, wood duck, and blue-winged teal.

The MGFC expressed the belief that food plantings specifically managed to

attract ducks was not necessary at Okatibbee due to the abundance of natural foods such as smartweed.

No published data are available with regard to waterfowl reproduction at Okatibbee. MGFC personnel have erected 200 wood duck nesting boxes on the OWMA and report that excellent results are being obtained. As an estimate of wood duck production, the MGFC wildlife manager on the OWMA proposed that the average wood duck clutch numbers 13 eggs per nest with a 50 percent success rate. Within these constraints, it was estimated that wood duck production approximates 1,300 birds per year solely from the artificial boxes installed on the Okatibbee project. Additional wood duck nesting of a totally unknown extent and success occurs on the project. Negligible reproduction by mallards or other waterfowl was reported.

A further exploration into the relative impacts of the Okatibbee project on wildlife resources was possible by comparing hunting effort and harvest per unit area of the project against similar harvest and effort measurements available for a larger area which includes the project. This was possible through the use of statistics compiled from a state-wide mail survey of game harvest conducted for 1976-77 by Mississippi State University in cooperation with MGFC (26). This study provided estimates of the total hunting effort and harvest of major game species for each of Mississippi's six Game Management Units.

The Okatibbee project lies within Planning Unit 5, an administratively distinguishable 13-county Game Management Unit in Mississippi. The Unit includes 7,699 sq mi, of which the Okatibbee project occupies 0.2 percent or

17.1 sq mi including all water areas. These data are presented in Table 6. The statistics presented representing harvest and effort for the complete Okatibbee project, includes 1,538 ha (3,800 ac) of water and 3,033 ha (7,494 ac) of land (68 percent land). This most certainly represents a lower proportion of terrestrial wildlife habitat than for Planning Unit 5 as a whole.

Even with this disadvantageous treatment of the Okatibbee data, the effort and harvest figures per unit area compare most favorably to the general area of the project (Planning Unit 5). In fact, excepting deer hunting (primitive and archery only) and turkey hunting (prohibited on Okatibbee), the use and harvest rates for the total project area including water, exceed the estimates for the more general area within which the Okatibbee project is located.

Comparison of average daily bags for squirrel, rabbit, quail and dove reflect higher success rates for squirrel and rabbit and lower success rates for quail and dove by Okatibbee hunters vs. the Planning Unit 5 averages (Table 7).

Recurring flooding of riparian lands located beside Okatibbee Creek below the project have prompted consideration by the CE of remedial action. The inability of the Okatibbee channel adequately to transport flood waters away from the project site has increasingly aggravated hydrological problems for the Okatibbee Dam and its appurtenant structures (Gene Russell, pers. comm., 1978). Depending upon the solution chosen, wildlife habitat within the 60.6 km (37.7 mi) area of impact, located between the dam and

Table 6. -- Comparison of annual harvest and hunting effort per square mile for the seasons 1975 to 1978 at the Okatibbee Lake Project (lands only vs. total land and water) and for Mississippi's Planning Unit 5 (1976-77) which includes Okatibbee Lake Project

Type of hunter	Hunter days per square mile		Harvest per square mile		
	Total area (land and water) Planning Unit 5	Okatibbee land area only	Total area (land and water) Planning Unit 5	Okatibbee area only	Okatibbee land area only
Deer (primitive weapon and archery only)	5.52	4.25	6.41	0.26	0.10
Turkey	5.84	Prohibited	Prohibited	0.51	Prohibited
Dove	13.99	15.54	22.72	83.86	76.88
Quail	8.82	18.29	26.73	27.30	32.89
Rabbit	16.79	43.82	64.05	22.23	168.84
Raccoon	5.94	9.00	13.15	6.21	5.82
Squirrel	40.24	57.84	84.55	89.05	212.24
Woodcock	1.24	N.A.	N.A.	2.18	N.A.

N.A. -- Data not available

**Table 7 . -- Comparison of average daily bag for small game hunters on the Okatibbee project (1975-78) with the 13 county MGFC Game Management Planning Unit 5 (1976-77)**

Species	<u>Average daily bag</u>		Ratio of Okatibbee bag to Planning Unit 5 bag
	Planning Unit 5	Okatibbee project	
Squirrel	2.2	3.7	1.7
Rabbit	1.3	3.9	3.0
Quail	3.1	1.8	0.6
Dove	6.0	4.9	0.8

the confluence of Okatibbee Creek and Chunky River, could be effected. The FWS has prepared a preliminary report on this issue. The report contains four alternative solutions to the flooding problem together with generalized projections of probable wildlife-associated impacts of each alternative (25).

Wildlife Resources -- Evaluation of Planning Input

The CE requested FWS comments on the proposed Okatibbee Lake project in 1961 and further requested that input be received within three months. The CE's survey report, for which FWS assistance was originally sought, was submitted to Congress seven months after the CZ contacted FWS. The FWS report was not released until 14 days after submission of the survey report to Congress. Apparently, the short lead time between notification and submission of the CE's survey report prevented the FWS from programming appropriate studies and providing the requested report by the desired date.

The first FWS report on the Okatibbee project was released on January 12, 1962. The document contained the only available quantitative descriptions of pre-project and post-project hunting effort. A severe loss of wildlife resources was projected as a result of the project as then envisioned. To mitigate project-associated wildlife losses, the FWS strongly recommended that approximately 1,133 ha (2,800 ac) of project lands above the programmed five-year flood pool be acquired in fee instead of in flowage easement as proposed by the construction agency. The Service was concerned that leaving the lands in private ownership (acquisition of easement only), would severely restrict public access for recreational use of the wildlife

resources contained thereon. The FWS further recommended that these lands be made available to the MGFC for development, operation, and maintenance. No developmental assistance or any other post-construction aid was requested from the construction agency, only the opportunity to use flood storage lands for wildlife management.

The 1962 report of the FWS also requested additional project storage to provide flow augmentation to improve water quality in the river below the project at Meridian, Mississippi. The request for low-flow augmentation supported a similar request submitted to the CE earlier by the U.S. Public Health Service. Passage of the Federal Water Pollution Control Act Amendments of 1961 provided authority to add water quality as a project purpose (1). At about the same time, the Departments of the Army and the Interior signed an interagency agreement regarding land acquisition at CE projects which allowed favorable consideration of the proposed acquisition in fee of those Okatibbee project lands previously planned for easement acquisition only. As a result of these two events, the project was modified by the CE to provide  $1.6 \times 10^7 \text{ m}^3$  (12,900 ac ft) of storage for water quality enhancement and to acquire in fee a total project area of 4,433 ha (10,955 ac).

The FWS responded to these additional project features in their report of August 17, 1964. Basically, this updated treatment simply supported the additional water quality storage and appraised the additional land acquisition as successful accomplishment of their (FWS) 1962 recommendation for such action.

The only wildlife-related recommendations by the FWS were: (1) to allow the MGFC to develop and manage suitable project lands for wildlife, and (2) to provide for reservoir use zoning. Although no updated wildlife population or wildlife-related recreational-use projections were provided, the FWS indicated that, with management of certain lands by the MGFC, the CE's plan for development would mitigate wildlife losses. If it is assumed the FWS meant full mitigation of wildlife losses, an assumption supported by the absence of quantified estimates of any residual wildlife losses, then the without-project conditions described quantitatively in the 1962 report provide appropriate estimates of expected post-construction conditions with full mitigation. That is, resident wildlife populations and hunting effort under state management of certain project lands were apparently expected to approximate their levels under pre-construction conditions in the absence of the project.

The MGFC had no comment to offer following their review of the 1964 report of the FWS. This lack of comment certainly implied state agreement with regard to the acquisition plan and the absence of any request for developmental assistance for wildlife purposes on project lands.

The 4,047 ha (10,000 ac) area considered in the 1962 report was expected to support increasingly greater hunting effort each year with a projected average annual hunting effort of 6,700 hunter-days over the 50-year period evaluated without the project. The annual rate of increase in hunting activity was expected to be four percent. Ten years after impoundment (1978) the hunting use of the project area, with no project-related adverse impacts, would have been 3,715 hunter-days. The projected 1978 hunting ef-

fort with respect to individual animal groups (as calculated using the predicted four percent annual increase) was 790 hunter-days for waterfowl, 425 hunter-days for deer, and 2,500 hunter-days for small game (predominantly rabbits, squirrels, and quail).

Approximately 2,024 ha (5,000 ac) of project lands (OWMA) were licensed to the MGFC for wildlife management purposes. This included certain lands that were proposed for state management in addition to those previously sought by the conservation agencies. Currently, hunting effort on the total project is estimated to average approximately 2,900 hunter-days, annually, including 356, 75, and 2,473 hunter-days for waterfowl, deer, and small game, respectively. The current moderate hunting use of the Okatibbee lands approximates the predicted levels when the interim nature of program development and population growth are considered. The moderate utilization, according to the MGFC, reflects at least partly the lack of adequate access to the OWMA.

The MGFC has been unable to install their waterfowl development plan for the Okatibbee licensed area. It was reported by MGFC staff that failure to construct the necessary dikes and improvements in order to provide sub-impoundment habitat prior to project completion has resulted in ground conditions in the work area which prohibit use of heavy machinery. As a consequence, only limited progress has been realized to date and the waterfowl management plans of the MGFC have gone largely unfulfilled. The beaver pond habitat at the lake's upper end (which add to the unworkable ground conditions) and the broad expanse of open water in the lower lake apparently combine to attract considerable numbers of migratory waterfowl.

in spite of the incomplete development. The estimated harvest of 600 ducks and geese in 356 hunter-days of effort prompted MGFC staff to characterize the project as the most important waterfowl hunting facility in the area.

Current water management strategies, adopted by the CE to provide the primary project benefits of flood control and water quality flows, have proven to be in substantial conflict with the needs of the wildlife resource functions of the project. As experienced in the fall and winter of 1973-74, drawdown of Okatibbee Lake earlier than the current schedule (November) would permit volunteer vegetation to develop around the winter seasonal pool. This development greatly enhanced the project attractiveness to migrating geese. An earlier drawdown (September) has been requested by the MGFC, pending adequate solution of any adversities (considered minor by MGFC) which such a plan may impose on other recreational uses of the larger summer pool (skiing and boating).

Promotion of wood duck reproduction has proved highly successful at Okatibbee. Two hundred nesting boxes have been installed and the estimated annual production from these boxes alone was 1,300 birds, more than twice the total annual waterfowl harvest at the project. While the project is producing more ducks (almost entirely wood ducks) than are being harvested, the harvest is not limited to wood ducks.

Optimum management of resident big-game wildlife on the Okatibbee project

is handicapped, according to state biologists, by the small size of the licensed lands. Deer hunting on the 2,015 ha (4,980 ac) CWMA, and on the additional 1,017 ha (2,520 ac) CE managed lands, is limited to primitive weapons and archery seasons. This restriction seriously constrains hunting effort for and harvest of deer on project lands. Firearm hunting around the periphery of the project is believed to result in the harvest of additional "Okatibbee" deer. No turkey hunting is permitted on project lands.

Small-game hunting effort and harvest on the limited lands available for such activity [approximately 2,290 ha (5,659 ac)] are estimated to be much higher per unit area than that estimated for the general 13-county area encompassing the Okatibbee project. In fact, the hunting effort per unit area computed for the total Okatibbee project, including the large expense of permanently inundated lands, was 2 times, 2.6 times, and 1.4 times greater for quail, rabbits, and squirrels, respectively, than reported for the 13-county area in general.

Greater success rates were experienced by rabbit hunters (2.9-fold) and squirrel hunters (1.7-fold) on the Okatibbee project, compared with the surrounding area. This circumstance indicated that the existing resource base for these two species could possibly support up to twice as much hunting effort as is being currently supported, yet continue to provide harvest rates comparable with the surrounding 13-county area.

These comparisons document the ability of proper game management (including law enforcement) to enhance wildlife communities. This allows replace-

ment of important wildlife communities which are lost through inundation. Unfortunately, such programs are expensive both for initial development and yearly operation and maintenance costs. No project funding to defray these wildlife-associated expenditures has been provided by the federal program responsible for the Okatibbee Lake project, even though federal funds were used to diminish the wildlife resource.

## FISHERY RESULTS AND DISCUSSION

### Fishery Resources -- Pre-impoundment Predictions

Although two separate planning reports were prepared and submitted to the construction agency by the FWS, only one (January 12, 1962) contained quantitative descriptions of pre-impoundment and post-impoundment conditions. The second report, released on August 17, 1964, discussed impacts of the updated project entirely in qualitative terms. Although the later report more accurately reflected the correct project dimensions and features, only the earlier report contained impact predictions. Therefore, the earlier document (1962) constitutes the basic planning instrument evaluated in this study. The 1962 report was also the document which contained the project design recommendations of the FWS related to fish and wildlife.

Prior to construction of the Okatibbee project, Okatibbee Creek in the project area supported a considerable recreational fishery, described by the FWS as follows:

The area evaluated for fishery resources and utilization extends from the juncture of Chunky and Okatibbee Creeks up Okatibbee Creek to about stream mile 46. Due to its influence on the lower reaches of Okatibbee Creek, the lower nine miles of Sowashee Creek was also investigated. This entails a total stream distance of about 55 miles.

Okatibbee Creek, within reservoir site and downstream near the mouth of Sowashee Creek, provides a very productive and heavily utilized sport fishery. Species taken include largemouth bass, bluegill, and other sunfishes, channel and flathead catfish, and suckers. It is estimated that over a 50-year period, this portion of the stream would provide about 2,680 fisherman-trips annually, valued at \$2,680.

Below the juncture with Sowashee Creek the quality of water and related fishery habitat deteriorates rapidly. Industrial waste

and other pollutants have practically eliminated the fish populations in Sowashee Creek and in the lower 17 miles of Okatibbee Creek. Zero fishery value is assigned to these waters. The condition improves rapidly through the dilution provided by Chunky Creek.

Rough fish are present within the area evaluated, but not in commercial quantities. It is not anticipated that a commercial fishery of any magnitude would develop under without-project conditions.

The monetary values quoted were based on the accepted schedule of recreational values assigned at that time (8).

The anticipated normal pool of 1,133 ha (2,800 ac) was expected to attract an average of approximately 53 angler trips per ha (21 trips/ac) annually, viz (FWS, 1962):

The stream fishery now provided by Okatibbee Creek would be replaced with a reservoir fishery. The reservoir would be classed as medium-sized and could be expected to provide good sport fishing. There is a scarcity of fishing opportunity within a wide radius of the proposed reservoir and the fishery would be of more than local importance, attracting sportsmen from central and eastern Mississippi and western Alabama. It is estimated that the reservoir would provide about 60,000 fisherman-trips and the downstream segment about 5,000 fisherman-trips annually. Thus, the incidental project-occasioned fishery benefit would amount to about 62,320 fisherman-trips valued at \$62,320 annually.

Reservoir habitat would be favorable for rough fish such as carp, buffalo, freshwater drum, shad, etc., and populations of these species could be expected to increase to the point where control measures would be required.

Land acquisition for wildlife mitigation, and provision of adequate public access comprised two of the three management recommendations developed by the FWS for the Okatibbee project. The third recommendation related to water quality improvement downstream from the dam as follows:

Pollution Abatement. If the area is to realize maximum benefits from its natural resources, water quality in its streams must be brought back to a state that would support a healthy, vigorous

biological environment. An opportunity to attain this state would be present in the proposed project, through allocation of storage to provide low-flow augmentation.

About 17 stream miles of the lower Okatibbee Creek, now polluted, could be restored to a vigorous biological environment if adequate flows could be provided. It is estimated this stream segment would support about 2,000 fisherman-trips annually, valued at \$2,000, by providing adequate dilution for treated waste entering from Sowashee Creek.

Findings of the Public Health Service reveal that 5 parts of dilution water would be required for 1 part of treated wastes discharged to restore the stream to a productive fishery. Your office has informed the Bureau [FWS] that the project would provide a minimum downstream flow of 20 c.f.s. This flow is about 3 times as great as the average amount of all wastes now being discharged into Sowashee Creek from the city of Meridian. Much of the waste is treated before it is discharged into Sowashee Creek, but the Public Health Service estimated that industry is presently discharging 0.78 m.g.d. of untreated sanitary and industrial wastes into storm drains and into Sowashee Creek.

Assuming that all wastes will be treated before being discharged into the streams, present requirements of dilution waters would be about 38 c.f.s. Based on the Public Health Service's projection that the city of Meridian will be discharging about 20 m.g.d. of treated wastes by the year 2015, requirements for dilution water will increase to about 150 c.f.s. by that year.

It is recognized that there will be a limit to the amount of water that could be stored in the reservoir during high runoff periods for future augmentation of low flows because of encroachment into flood storage. Also during drought years, adequate storage for dilution may not be possible. Consequently, hydrologic studies are needed to determine the number of years that adequate dilution water could be provided in compatibility with other project requirements. The Bureau, therefore, requests the Corps, in conjunction with other agencies concerned with maintenance of quality water, to determine the feasibility of providing adequate dilution water to restore a vigorous biological environment in the lower 17 miles of Okatibbee Creek through project operations.

As described in the preceding discussion of wildlife planning, the CE altered the project to incorporate storage for downstream water quality improvement, a feature which was also recommended by the U.S. Public Health

Service. This additional project feature necessitated an updated report on fish and wildlife impacts which the FWS released in August, 1964. Although the added storage inundated an additional 445 ha (1,100 ac), creating a normal summer pool of 1,538 ha (3,800 ac) instead of 1,093 ha (2,700 ac), no added angler use was projected in the 1964 report over the level of use estimated in the 1962 document. The following passage from the FWS report of 1964 to the CE reflects the Service's unmodified reaffirmation of their 1962 projections:

On January 12, 1962, this Bureau submitted to you a report on the fish and wildlife aspects of the Okatibbee Creek Reservoir project as then being considered. Latest field reconnaissance confirms the evaluation given in that report. [Emphasis added]. Our findings contained herein are based on analysis of updated engineering data and additional recommended features, as described in your General Design Memorandum No. 2, March 1964.

The project-associated sport fishery was discussed in three brief paragraphs, as follows:

The additional 1,100 acres of water will be generally shallow, ranging from 4 feet in depth to feather edges. Minor fluctuations in pool elevation will expose or inundate relatively large expanses of mud flats. Boating will be hazardous or impractical over much of the area. Through portions of the year, however, the area will provide more fishery habitat and be utilized by fishermen. Inundation will normally be during fish spawning periods and may lead to overpopulation of rough fish.

Although Okatibbee is a rather small stream at the damsite, it is anticipated that operational flows will provide a moderate tail water fishery. To provide maximum benefits to sport fishermen, we suggest that access be provided to the immediate downstream reach of Okatibbee Creek.

We are pleased to note that you propose to initiate dam closure operations in August and to complete the entire main dam prior to the beginning of the flood season in November. Initial impoundment will not occur during the spawning period of forage fishes, and thus will favor a better balanced fish population in the reservoir. Fish stocking and reservoir management should be in accordance with recommendations and policies of the Missis-

sippi Game and Fish Commission.

The FWS believed that the added storage for low-flow augmentation was sufficient to protect the downstream fishery, viz:

We believe these criteria are adequate to provide suitable water quality for reestablishment of the downstream fishery.

This improvement in water quality, it should be noted, was dependent upon inclusion of an epilimnia discharge structure. The FWS made a point of this in their description of the CE's planned intake design as follows:

As the seasonal pool elevation 343 feet, the reservoir will have storage space of 12,900 acre-feet for downstream water-quality control. The outlet works will consist of gated intake structure, a triple box conduit with air vents, and a stilling basin. An approach channel 40 feet wide with bottom at elevation 330 feet will be provided upstream from the structure. This will mean that, except for periods of flood storage, water will be drawn from no deeper than 13 feet. Water quality, in regards to temperature and dissolved oxygen, will meet requirements to maintain the warm-water downstream fishery.

To assure maximum fishery values at Okatibbee Lake, the FWS recommended, (1) preparation of a reservoir zoning plan, (2) access development in the tailwater area, and (3) dam construction and operation in a manner conducive to sustaining a warmwater fish population.

Although not noted in the 1964 FWS report, which was qualitatively oriented and which simply reiterated support of the earlier 1962 report, the FWS staff did expect the larger reservoir to attract greater numbers of anglers than the previously designed smaller project. Informal, handwritten notes contained in the project records on file at the Decatur, Alabama, office of the FWS express the belief that the water impounded for water quality enhancement would support 12,600 additional angler-trips thereby

generating a total annual usage of approximately 72,600 angler-trips. The term angler-trip, as employed throughout this report, denotes one angler's fishing trip for a complete or any portion of a day.

The MGFC reviewed the 1964 report of the FWS and provided a perfunctory, one-sentence statement, viz (11):

We do not have any comment to make on your report on the Okatibbee Creek Reservoir, Mississippi, study.

Little record remains to permit reconstruction of the means by which the author(s) of the FWS reports developed fishery-related predictions. Therefore, no analysis of the technique's strengths nor weaknesses can be undertaken in this study except to examine the accuracy of the predictions.

Water quality aspects of the project area were monitored by the MGFC during the construction period (27). This review examined the effects of pollutants on fish life and bottom organisms.

In January, 1965, a supplement to the CE's Design Memorandum No. 2 presented a significant modification of the outlet structure. It provided, rather than releasing well-oxygenated water from the upper portion of the lake, that water was to be released from a much deeper level. Upon discovery of this design change (discovered in 1969 after lake completed), the Federal Water Pollution Control Administration (now EPA) advised the CE (2):

It would be unfortunate if design modifications made subsequent to the earlier Public Health Service water resource study should reduce benefits from water quality storage. This is particularly true for the Okatibbee Reservoir, the first of its type in the Southeast.

This situation will be discussed in greater detail in subsequent sections of this report.

Fishery Resources -- Post-impoundment Occurrences

The gates at the Okatibbee project were closed November 26, 1968, and the pool reached full winter conservation elevation on February 2, 1969. The lake is managed with two seasonal pools. From May through October the lake is held near elevation 104.5 m (343 ft) msl thereby providing 1,538 ha (3,800 ac) of impounded surface area. During the remaining months, the lake is lowered to elevation 103.3 m (339 ft) msl in order to increase project capacity for flood storage. This winter pool covers 1,101 ha (2,720 ac).

The average annual inflow at Okatibbee is estimated at 200 cfs. This inflow would produce a water exchange rate of 105 days, adequate to replace the conservation pool volume 3.5 times per year. The waters feeding Okatibbee Lake are relatively unpolluted and are low in nitrogen and phosphorus (28). The outlet works extended from elevation 94.5 m (310 ft) to 97.8 m (321 ft), considerably below the lake surface.

Prior to project construction, the mean annual discharge at the damsite was 203 cfs. The 7-day low flow with a 10 year recurrence interval was 1.3 cfs (3). The three programmed minimum flow releases from the Okatibbee project are 10 cfs during November through March, 50 cfs in the months of April through June and October, and 100 cfs during July, August and September (1).

The project's success in attainment of the summer releases (100 cfs) was described in the CE's environmental impact statement as follows, viz (3):

The U.S. Geological Survey is currently recording surface water data and water quality from three stations in the Okatibbee Basin. The first of these, station 4760, is located on Okatibbee Creek 16.2 miles downstream from the dam. The second station, 4765, is located on Sowashee Creek at Meridian approximately 8 miles upstream from the mouth. The third station, 4766, is on Okatibbee Creek at Arundel, Mississippi, below its junction with Sowashee Creek and 21.3 miles below the reservoir. Station 4766 is monitored by the Corps of Engineers using telephone equipment. Stream flow data from this gage are used to determine the discharge from the reservoir outlet. Reservoir operation during the critical months of July, August, and September, requires that a flow of 100 cfs be maintained to enhance water quality below the city of Meridian. During these months for the years 1970, 1971 and 1972, flows of less than 100 cfs occurred 64%, 35%, and 80% of the days, respectively. The releases from Okatibbee Lake were less than specified because of an incorrect rating curve for the Arundel gage. The error in the rating for this station has been corrected and the curve has been revised. Consequently, there were no days in 1973 when the flow at this station was less than 100 cfs during July, August, and September, and it is expected that the established flow requirements will be met in the future.

The Fisheries Division of the MGFC initiated fisheries investigations at Okatibbee on March 1, 1971. These continuing studies have included fish introductions, creel surveys, fish population studies, and selective fish control measures.

The fish community of Okatibbee Lake resulted largely from expansion of the resident fish community of Okatibbee Creek after its inundation by the newly created lake. Supplementary plants of hatchery fish were also made for selected species, including striped bass. Table 8 summarizes the fish stocking records for the period 1969 through 1974 (28,29).

The Okatibbee sport fishery includes two components, a reservoir fishery and a tailrace fishery. Effort and harvest data are available only with respect to the reservoir fishery. These data were published covering a continuous

Table 8 . -- Stocking record for Okatibbee Lake

Species	Year(s) stocked	Numbers stocked	Size stocked
Striped bass	1969	1,289	Fingerling
	1970	1,000	Fingerling
	1971	1,200	Fingerling
	1972	35,000	Fingerling
	1973	20,000	Fingerling
	1974	61,500	Fingerling
Largemouth bass	1969	149,000	Fry
	1974	64,073 <sup>1/</sup>	Fingerling & adult
Bluegill	1969	503,000	Fingerling
Redear sunfish	1969	40,000	Fingerling
Threadfin shad	1974	7,800	Adult

1/ Included 24,000 fingerling Florida strain, 40,000 fingerling Northern strain and 73 adult

period of 58 months beginning March 1, 1971, and ending December 31, 1975. A change in reporting format from fishing-year (March-February) to calendar-year affected the 10-month period reported for 1974. Available data were extracted from MGFC reports (30,31) to prepare Table 9 , which summarizes the creel survey statistics.

A total of 193,418 angler-trips at Okatibbee Lake were reported during the period March 1, 1971-December 31, 1975, averaging approximately 38,700 trips per year. The angler surveys did not include night fishing at Okatibbee. The night-time effort, particularly the trot-line component, is believed to be increasing. It was suggested by MGFC staff that angling effort after dark would not exceed five percent of the daytime fishing effort (Jack Herring, pers. comm., 1978). Therefore, increasing the average yearly effort (38,700 trips) by five percent provides an estimated total reservoir angling effort amounting to 40,600 trips per year.

Unfortunately, no data were collected from the tailrace immediately below the dam. Apparently this fishery has developed gradually over the years and was not of sufficient magnitude during the earlier years to warrant study. During the field-trip for this investigation, many anglers were observed fishing in the tailrace, and local CE personnel indicated that this is a common occurrence (Bill Pennington, pers. comm., 1978). Based on discussions with the responsible MGFC fishery biologist, an average annual angling effort of 12,000 angler-trips was suggested for the tailrace fishery (Bill Pennington and Jack Herring. pers. comm., 1978). This was considered to be a rough estimate which included both day and night fishermen.

Table 9. -- Summary of creel survey statistics for Okatibbee Lake as computed by the MGFC

	Survey Periods					
	March 1, 1971- February 29, 1972	March 1, 1972- February 28, 1973	March 1, 1973- February 29, 1974	March 1, 1974- December 31, 1974	January 1, 1975- December 31, 1975	
No. angler-trips	45,719	31,416	33,338	24,293	58,652	
No. angler-hours	170,885	126,236	165,509	136,161	191,722	
No. fish harvested	137,219	98,067	168,978	102,190	240,224	
- Wt. fish harvested						
Kg.	42,216	29,808	48,935	25,237	63,244	
Lbs.	93,070	65,715	107,884	55,638	139,429	

1. Survey period only 10 months long

Summing the published reservoir creel survey data with estimates of the tailrace and night angling effort on the lake yielded a total angling effort estimate of approximately 52,600 trips per year.

Total reported numbers of fish harvested varied from a low of 98,067 in 1972-73 to a high of 240,224 in 1975. The total weight of fish harvested from the reservoir exhibited a two-fold variation from year to year over the survey period (Table 9 ).

The reported catch statistics accounted only for the day fishing in the lake. Consequently, it was necessary to increase these data to reflect the additional catches of night-time and tailrace anglers. Manipulation of the angling effort data to reflect the unquantified tailrace and night-time fishing resulted in expansion of the average reported daytime lake-associated effort by approximately 38 percent. Assuming that night-time and tailrace anglers were approximately as successful as were daytime fishermen [3.9 fish weighing 1.08 kg (2.38 lbs) per trip], the average harvest from the total Okatibbee complex would approximate 214,500 fish weighing 59,400 kg (130,952 lbs) per year.

Sport harvest by species was ascertained through examination of the creels of an average of 1,200 anglers per year, approximately two percent of the estimated total number of anglers. The MGFC reports did not present the estimated total harvest by individual species. Percent composition of the sampled catches examined, however, were reported by species. Tables 10 and 11 present these data, which were extracted from the MGFC reports (30,31).

It is apparent that crappies and bass combined to contribute 80 to 90 per-

Table 10. -- Percentage composition by numbers in creel, Okatibbee Reservoir, 1971-1975

Species	Years				
	1971-1972	1972-1973	1973-1974	1974	1975
Largemouth bass	27.15	20.64	14.76	13.58	14.13
Spotted bass	0.10	0.00	0.03	0.00	0.04
White crappie	10.10	26.69	34.02	30.97	46.84
Black crappie	11.05	18.11	26.44	22.15	22.34
Bluegill	39.21	20.52	15.83	16.78	8.22
Rearear	0.79	1.74	1.45	9.56	2.01
Warmouth <sup>1</sup>	1.97	2.14	1.63	1.73	0.88
Channel catfish	0.36	0.45	0.30	0.22	0.83
Bullheads	8.16	8.86	4.98	4.54	4.47
Pickeral	0.43	0.40	0.33	0.26	0.00
Others <sup>2</sup>	0.69	0.45	0.24	0.21	0.18

1. Includes longear

2. Mostly bowfins

Table 11. -- Percentage composition by weight in creel, Okatibbee Reservoir 1971-1975

Species	Years				
	1971-1972	1972-1973	1973-1974	1974	1975
Largemouth bass	65.99	60.19	47.07	48.34	39.81
Spotted bass	0.20	0.00	0.03	0.00	0.03
White crappie	5.11	13.09	26.53	16.92	32.45
Black crappie	4.96	7.98	13.02	13.57	15.31
Bluegill	13.17	5.86	4.85	6.53	3.21
Redear	0.41	0.57	0.55	4.77	1.01
Warmouth <sup>1</sup>	0.60	0.59	0.51	0.64	0.00
Channel catfish	0.47	0.95	0.81	0.64	1.70
Bullheads	5.48	7.07	4.31	6.03	5.34
Pickeral	0.90	1.22	0.74	0.76	0.00
Others <sup>2</sup>	2.70	2.51	1.58	1.80	0.74

1. Includes longear

2. Mostly bowfins

cent of the harvest by weight during each year. The two species of crappies, bluegills, and largemouth bass comprised approximately 90 percent of the annual catches in numbers caught. Certain trends appear in the data; an increasing contribution by the two species of crappies and decline in the relative contribution of largemouth bass and bluegills are the most striking changes.

The average weights of fishes harvested at Okatibbee Lake generally remained rather constant over the period 1971 to 1975 (Table 12). These data reflect relatively large fish comprising the creel. By 1975, largemouth bass averaged 0.77 kg (1.70 lbs) and crappies averaged 0.19 kg (0.42 lbs).

Two or three coves ranging in size from 0.4 to 1.2 ha (1 to 3 ac) were sampled annually with rotenone to determine species composition and standing crops of fishes in Okatibbee Lake. These data are presented for seven consecutive years in Table 13. Cove rotenone sampling does not provide dependable standing crop estimates for all species. It provides a more accurate index of population densities for those species associated with shallow water and the lake shore zone.

The cove rotenone data reflected a gradual decline in total standing crop. Although the contributions of largemouth bass, bluegills, and warmouths declined between 1971 and 1977, the reduction in total biomass was largely the result of gizzard shad control. The population sampling data for Okatibbee Lake indicated an overabundance of gizzard shad in size ranges unavailable for the majority of game fish in the lake. In October 1973, the CE and the MGFC cooperatively planned and executed a selective fish control

Table 12. -- Average weight of various species in creel, Okatibbee Reservoir 1971-1975

Species	1971-1972		1972-1973		1973-1974		1974		1975	
	Kg (Lbs)									
Largemouth bass	0.74	1.64	0.88	1.94	0.94	2.08	0.89	1.96	0.77	1.70
Spotted bass	0.64	1.40	0.00	0.00	0.27	0.60	-	-	0.25	0.55
White crappie	0.15	0.34	0.15	0.33	0.23	0.51	0.14	0.30	0.19	0.42
Black crappie	0.14	0.30	0.13	0.29	0.15	0.32	0.15	0.34	0.19	0.41
Bluegill	0.10	0.23	0.09	0.19	0.09	0.20	0.10	0.21	0.11	0.24
Redear	0.16	0.35	0.10	0.22	0.11	0.25	0.13	0.28	0.14	0.30
Vermouth <sup>1</sup>	0.10	0.21	0.08	0.18	0.09	0.20	0.09	0.20	-	-
Channel catfish	0.40	0.88	0.64	1.42	0.81	1.79	0.73	1.62	0.56	1.24
Bullheads	0.20	0.45	0.24	0.53	0.25	0.56	0.33	0.73	0.33	0.72
Pickeral	0.65	1.43	0.92	2.02	0.67	1.47	0.73	1.62	-	-
Bowfin	-	-	-	-	-	-	2.09	4.60	1.11	2.44

1. Includes longear

Table 13. -- Numbers and weight per acre of fish collected from Okatibbee Reservoir, 1971-1977

Species	1971		1972		1973		1974	
	No.	Weight Kg (Lbs)	No.	Weight Kg (Lbs)	No.	Weight Kg (Lbs)	No.	Weight Kg (Lbs)
Largemouth bass	67.00	9.42 (20.76)	59.67	7.92 (17.46)	68.33	6.50 (14.33)	57.00	5.74 (12.65)
Spotted bass	0.00	0.00 (0.00)	0.00	0.00 (0.00)	0.00	0.00 (0.00)	1.00	0.01 (0.02)
White crappie	10.00	0.42 (0.93)	400.67	19.55 (43.11)	48.33	0.47 (1.03)	112.67	4.84 (10.67)
Black crappie	9.75	0.46 (1.02)	375.67	8.75 (19.30)	60.67	0.44 (0.98)	157.67	4.82 (10.62)
Chain pickerel	2.00	0.46 (1.02)	3.00	1.46 (3.22)	1.00	0.03 (0.06)	0.67	0.09 (0.20)
Bluegill	3185.50	27.93 (61.58)	3283.00	15.93 (35.11)	977.67	10.39 (22.91)	770.67	13.05 (28.77)
Redear	23.00	1.57 (3.46)	265.33	0.56 (1.26)	7.67	0.35 (0.78)	3.67	0.50 (1.11)
Longear	68.25	0.73 (1.60)	108.00	0.61 (1.35)	48.67	0.57 (1.25)	196.33	1.17 (2.59)
Green sunfish	65.75	0.27 (0.59)	26.67	0.05 (0.11)	7.00	0.09 (0.20)	14.33	0.06 (0.14)
Wearmouth	56.00	0.75 (1.66)	1169.00	0.99 (2.19)	38.67	0.49 (1.07)	38.67	0.29 (0.63)
Spotted sunfish	6.25	0.06 (0.14)	1.67	0.03 (0.07)	5.33	0.05 (0.14)	0.00	0.00 (0.00)
Spotted sucker	8.50	4.89 (10.78)	2.00	1.07 (2.36)	0.00	0.00 (0.00)	0.00	0.00 (0.00)
Carp	0.00	0.00 (0.00)	1.00	2.51 (5.54)	0.00	0.00 (0.00)	0.33	2.81 (6.20)
Channel catfish	2.50	0.12 (0.26)	2.33	2.53 (5.57)	0.00	0.00 (0.00)	1.00	0.93 (2.06)
Flathead	0.00	0.00 (0.00)	0.00	0.00 (0.00)	0.00	0.00 (0.00)	0.00	0.00 (0.00)
Bullheads	4.50	0.79 (1.74)	21.67	0.20 (0.45)	1.33	0.02 (0.06)	0.00	0.00 (0.00)
Spotted gar	0.20	0.01 (0.03)	0.00	0.00 (0.00)	0.00	0.00 (0.00)	0.33	0.02 (0.04)
Bowfin	1.75	3.17 (6.98)	2.00	2.32 (5.12)	0.33	0.56 (1.23)	0.00	0.00 (0.00)
Gizzard shad	936.25	43.93 (96.85)	2847.67	95.86 (211.33)	1223.33	43.04 (94.89)	914.33	28.35 (62.50)
Threadfin shad	0.00	0.00 (0.00)	0.00	0.00 (0.00)	0.00	0.00 (0.00)	751.33	1.89 (4.16)
Misc. Minnows	38.50	0.03 (0.07)	120.33	0.12 (0.27)	6.67	0.01 (0.03)	46.00	0.07 (0.15)
Madtom	2.00	Trace	0.00	0.00 (0.00)	2.67	0.01 (0.02)	16.33	0.02 (0.05)
Pirate perch	0.00	0.00 (0.00)	3.67	0.01 (0.03)	0.00	0.00 (0.00)	0.00	0.00 (0.00)
Total	4487.70	95.01 (209.47)	8693.35	160.47 (353.83)	2497.67	63.03 (138.96)	3082.33	64.66 (142.39)

Table B . -- (Continued)

Species	1975			1976			1977			Average Weight (Lbs)	
	No.	Weight (lbs)		No.	Weight (lbs)		No.	Weight (lbs)			
		Kg	(Lbs)		Kg	(Lbs)		Kg	(Lbs)		
Largemouth bass	95.00	3.74	(8.25)	71.33	3.61	(7.96)	71.67	2.79	(6.15)	70.00	
Spotted bass	0.00	0.00	(0.00)	0.00	0.00	(0.00)	0.00	0.00	(0.00)	0.14	
White crappie	131.33	2.09	(4.61)	85.00	0.82	(1.80)	233.67	1.77	(3.90)	145.95	
Black crappie	51.00	0.69	(1.53)	62.00	0.79	(1.75)	176.67	1.08	(2.39)	127.63	
Chain pickerel	0.33	0.10	(0.21)	1.00	0.05	(0.10)	0.67	0.29	(0.63)	1.24	
Bluegill	1317.67	9.75	(21.49)	505.67	6.37	(14.04)	503.67	5.07	(11.18)	1506.26	
Redear	85.67	0.95	(2.09)	14.00	0.50	(1.12)	64.67	1.62	(3.57)	66.29	
Longear	192.33	1.06	(2.24)	52.00	0.76	(1.67)	35.00	0.53	(1.16)	100.08	
Green sunfish	10.67	0.05	(0.11)	5.67	0.03	(0.07)	0.00	0.00	(0.00)	0.78	
Varmouth	52.00	0.34	(0.76)	3.00	0.09	(0.19)	6.33	0.05	(0.11)	18.58	
Spotted sunfish	0.00	0.00	(0.00)	0.33	Trace	Trace	0.00	0.00	(0.00)	194.81	
Spotted sucker	0.00	0.00	(0.00)	0.33	0.06	(0.13)	8.67	1.27	(2.79)	1.94	
Carp	0.00	0.00	(0.00)	0.00	0.00	(0.00)	2.67	0.69	(1.53)	0.02	
Channel catfish	1.33	0.09	(0.19)	0.33	0.33	(0.73)	0.67	0.62	(1.37)	0.57	
Flathead	0.33	0.23	(0.50)	1.00	0.27	(0.60)	0.33	0.50	(1.10)	0.24	
Bullheads	0.66	0.12	(0.27)	0.33	Trace	Trace	0.33	0.14	(0.30)	0.18	
Spotted gar	0.33	0.01	(0.02)	0.33	0.26	(0.53)	0.33	0.10	(0.23)	0.22	
Bootstrap	0.00	0.00	(0.00)	0.00	0.00	(0.00)	2.33	3.63	(8.00)	0.92	
Gizzard shad	482.67	31.76	(70.01)	1487.33	30.13	(66.42)	1487.00	18.88	(41.63)	1339.80	
Threadfin shad	884.33	2.75	(6.07)	5306.33	7.30	(16.09)	0.00	0.00	(0.00)	991.70	
Mac. Minnow	1504.00	1.37	(3.03)	617.33	0.71	(1.56)	164.00	0.60	(1.33)	356.69	
Mudstone	28.00	0.02	(0.05)	18.33	0.02	(0.05)	41.67	0.04	(0.08)	15.57	
Pirate perch	0.00	0.00	(0.00)	0.00	0.00	(0.00)	0.00	0.00	(0.00)	0.52	
Total	4837.65	55.12	(121.53)	8231.64	52.08	(116.81)	2800.35	39.67	(87.45)	4947.23	
										74.85 (167.23)	

effort. This treatment, which resulted in elimination of an estimated 111 kg per ha (99 lbs per ac) of gizzard shad, was followed in the spring of 1974 with the introduction of 7,800 adult threadfin shad. The threadfin population increased tremendously prior to its destruction by winter-kill in 1977 (31).

Table 14 reflects the abundance of young-of-the-year fish in Okatibbee Lake. The rapid expansion of threadfin shad is quite apparent. Relatively stable year-classes characterize the largemouth bass and crappie populations.

Okatibbee Creek below the dam has been the object of several continuing studies that address chronic flow and water quality problems. Retarded passage of flood water and flooding of stream-side properties continue to cause concern. The stream channel capacity for flood-water release was miscalculated by the CE during the design phase. This design deficiency has been aggravated by downstream flow blockage problems. The affected agencies (FWS and CE) are currently studying methods of alleviating these conditions. Among the proposed alternative courses of action being considered are no action, clearing and snagging, acquisition of flood easements, and a floodway (25). The MGFC favors the acquisition of flood easements as a non-structural solution to the problem (32).

The Okatibbee project was originally authorized to store and release water for the dilution of downstream pollution problems. Such function is, however, no longer considered an acceptable pollution abatement policy and use of the project stored water. Specifically, in 1976, in response to a query

Table 1a. -- Number of young-of-year of the major species per unit area from Okaribee Reservoir 1971-1977

Species	1971		1972		1973		1974		1975		1976		1977	
	Per ha	Per ac												
Largemouth bass	62	25	76	30	126	51	153	62	195	79	166	59	124	50
Crappie <sup>1</sup>	17	7	1,436	581	232	94	326	132	366	148	319	129	1,297	525
Bluegill	4,469	1,917	5,851	2,368	1,186	488	729	295	2,098	869	405	164	909	368
Redear	96	39	638	258	3	1	0	0	168	68	5	2	114	46
Womouth	7	3	2,889	1,169	47	19	57	23	89	36	3	1	15	6
Longear	47	19	217	88	62	25	383	155	277	112	40	16	5	2
Bullhead	0	0	52	21	3	1	0	0	0	0	0	0	0	0
Gizzard shad	32	13	0	0	17	7	1,166	472	0	0	2,787	1,128	3,170	1,283
Threadfin shad	0	0	0	0	0	0	1,950	789	2,186	884	13,111	5,306	0	0

1. Black and white crappie

from the CE, the Environmental Protection Agency (EPA) advised, "it is recommended that the storage for water quality control be reallocated for other purposes in this reservoir to be consistent with current policies regarding storage for water quality control..." For this reason the Corps is proceeding to evaluate other possible needs for storage and flow regulation (33).

The project, itself, has proven to be a cause for concern with regard to water quality degradation. Prior to impoundment, but subsequent to release in 1964 of the FWS's planning report, the construction agency altered the design of the Okatibbee Lake outlet structure. A review of these events is presented following, as summarized by the FWS (op cit):

In the BSF&W report covering fish and wildlife impacts of the project, the then-proposed design of the dam was deemed satisfactory from the standpoint of ability to meet dissolved oxygen requirements to the downstream fisheries. This report set forth the need to provide an oxygen concentration of 4.0 mg/l in project releases to maintain viable downstream fisheries. However, a preimpoundment study of FWPCA and their report, dated January 1969, predicted reservoir stratification and a lowered dissolved oxygen content in downstream releases as a result of the 1965 project modification. It was recommended that if water quality damage persisted beyond a 2 or 3 year stabilisation period following construction, mitigation measures could be taken to correct the situation. Should water quality downstream be unsatisfactory to support a year-round healthy fish environment, measures should be incorporated in the project to correct the situation. Such action would be in keeping with congressional resolution providing for review of existing projects to ascertain if changes in structures or operations are advisable to help meet present day needs including water quality, recreation, fish and wildlife, and other uses. These problems and possible remedial measures should be thoroughly discussed in this section of the final EIS.

The CE is studying this potential water quality problem at Okatibbee Lake. To determine pH, temperature, and dissolved oxygen in Okatibbee releases,

the CE installed an automatic water quality monitor in 1970 immediately downstream from the tailrace. The equipment has never operated to its full potential since installation. In fact, the CE reported in 1977 that only 14 percent of the data gathered over the preceding five years were reliable (33).

The impact of the Okatibbee water releases on the downstream fishery follows, as summarized by the CE (op cit):

c. Downstream Fishery. The releases from Okatibbee Dam have no significant impact on either the fish or the quality of fishing within the immediate vicinity below the Dam according to both State or Federal water quality criteria. However, an oxygen sag, which develops during the summer months as a result of Lake stratification, may cause the dissolved oxygen to drop below State Standards in sections of Okatibbee Creek, resulting in a fish migration away from the area of depressed oxygen concentration. This migration may tend to concentrate the fish into areas of high dissolved oxygen concentrations immediately below the Dam which may be partially responsible for the good fishing currently being experienced within the tailrace of Okatibbee Dam. There have been no reported fish kills. Less motile organisms within the aquatic ecosystem are not thought to be significantly affected by the dissolved oxygen concentrations or other chemical water parameters within the waters of Okatibbee Creek between the Dam and its confluence with Sowashee Creek.

The following recent FWS description of the downstream Okatibbee Creek fishery seems to be in substantial agreement with the preceding evaluation (25):

The first one-half mile below the dam is heavily utilized by fishermen. A large discharge from the dam usually results in heavy pressure in this area. Utilization is generally light to the juncture of the Sowashee except for moderate use by float fishermen. Float fishing success is considered good, particularly from old Highway 80 to Highway 11 crossings. Because of fallen trees, the stream is difficult to float above this point. Fishermen have noted rather large populations of both longnose gar (Lepisosteus osseus) and spotted gar (Lepisosteus oculatus) while floating.

Access to the creek is highly limited. This apparently does not deter fishing activity as evidenced by bank fishermen and the

numerous set hooks along the bank.

Fisheries biologists with the MGFC have not quantitatively evaluated the project's impact on the downstream fishery. It is generally believed, however, that there has been little basic change as a direct result of project construction although there has been an improvement in water quality in the vicinity of Meridian, Mississippi, which may have improved the stream fishery (Jack Herring, pers. comm., 1978).

#### Fishery Resources -- Evaluation of Planning Input

The fishery-related predictions and planning recommendations evaluated in this study were those submitted by the FWS to the CE in early 1962. A later updated report, released by the FWS in 1964, reaffirmed their earlier comments but provided little additional information of use to the project planners.

A total distance of 89 km (55 mi) were evaluated in the FWS's pre-construction report. Of the 89 km evaluated, about 42 km (26 mi), comprising the lower sections of Okatibbee Creek and Sowashee Creek, were affected by industrial pollutants and considered to have no existing fishery value. The upper 47 km (29 mi) of Okatibbee Creek and its tributaries were described as maintaining a productive sport fishery which supported 2,680 angler-trips annually.

Following construction of the Okatibbee project, as perceived by the project planners in 1962, the sport fish community and angling use of the lake and remaining stream system were expected to benefit. At that time, the lake was expected to include only 1,133 ha (2,800 ac) of surface area,

and the post-construction angler-use estimate provided by the FWS for that size lake was 60,000 angler-trips annually. The downstream fishery was also expected to benefit and attract 5,000 angler-trips, annually. The mechanism which was anticipated to lead to this improved stream fishery was not clear.

The FWS and other agencies expressed considerable interest at that time (1962) in the opportunity provided by the project to furnish dilution water for improvement of water quality in the lower section of Okatibbee Creek. The CE determined that this purpose could be met with additional storage, and redesigned the project accordingly. Following inclusion by the CE of downstream water quality improvements as a project purpose, the lake was redesigned and enlarged to provide a seasonal pool of 1,538 ha (3,800 ac). This resulted in a 36 percent increase in the expected area of lake surface. Calculations of the impact of the additional water area were carried out by the FWS; results indicated that 12,600 additional angler-trips could be expected to occur annually on the larger lake. Nevertheless, no formal corrections of the previously (1962) predicted level of angler-use of the lake was forthcoming.

In summary, the reservoir was predicted to support 60,000 angler-trips of fishing use annually, and the downstream segment was expected, with improved water quality, to support 7,000 angler-trips. The net increase in angler-use of the project area was projected to be 64,320 angler-trips. As noted, the FWS computed but did not advise the CE that they expected that additional lake-related benefits amounting to 12,600 angler-trips

would result from the significant enlargement of the project for water quality releases.

The predicted level of angler-use was reasonably close to currently estimated actual exploitation rates for the reservoir proper. The actual average day and night fishing effort was estimated at 40,600 trips annually over the nearly 5-year period, March 1, 1971, to December 31, 1975. This compares to the predicted average annual use of 60,000 angler-trips. It should be noted that the MGFC reported that approximately 58,652 fishing trips occurred at Okatibbee Lake during calendar year 1975.

Utilization of the "downstream segment," with adequate water quality conditions, was expected to average only 7,000 angler-trips. The current use of the immediate area of the tailrace, according to an informed professional judgement rendered jointly by CE and MGFC personnel, amounts to 12,000 angler-trips annually. No estimate of angler-use of Okatibbee Creek below the immediate area of the tailrace is available. It would appear reasonable to conclude, however, that the downstream section of Okatibbee Creek impacted by the project, including tailrace, supports approximately double the 7,000 angler-trips predicted prior to construction.

CE estimates of angler visitations at Okatibbee are many times greater than the use estimates developed by the MGFC. As examples, the CE estimated angling effort was 278,392 angler-trips for 1973 (3), and 355,400 angler-trips in 1974 (7).

This evaluation would tend to support the FWS's summary of this discrepancy

in reported recreational use of the project, as follows (op cit):

The Corps of Engineers visitor day estimates and subsequent breakdown by activity (such as boating, picnicing, fishing, hunting, swimming, etc.) are based on observations of the resource manager and vehicle counting devices. The Mississippi Game and Fish Commission utilized actual fisherman counts each two hours of a fisherman interview day which was conducted one week day per week and on alternate Saturdays. Although no method of estimation will yield complete accuracy, it is believed the estimates developed by the Mississippi Game and Fish Commission are much more accurate than the Corps of Engineers estimate.

The post-construction reservoir fish community was expected to consist of largemouth bass and an assemblage of sunfishes and catfishes of several species. The pre-construction planners could not have been expected to anticipate the MGFC's eventual decision to establish a landlocked striped bass fishery at Okatibbee Lake. Today's planners ought, certainly, to consider the potential impacts of diversification of endemic fish communities through introduction of non-native predators. This management strategy is currently employed at most artificial reservoirs such as Okatibbee Lake.

The pre-construction report did envision good sport fishing at Okatibbee Lake and the available data would certainly support that projection. The FWS report also contained a statement relating to the possibility of the eventual proliferation of less desirable species and the need for application of control measures. The actual "control measures" envisioned by the authors were not elucidated nor were construction or operational recommendations provided relating to such control measures. The predicted eventual requirement for reducing unwanted population components was well taken, judging by the selective shad control program deemed necessary and

conducted in 1973. This particular control effort, which involved lowering the lake and applying the piscicide, rotenone, is noted as an excellent example of interagency cooperation to enhance project-associated recreational fishery values.

Little standing timber was left in the lake basin during construction of the Okatibbee project. The CE reported, and the FWS and MGFC did not oppose, the total clearing of all timber up to the top of the seasonal pool, an area of 1,538 ha (3,800 ac). The protection and subsequent flooding of up to 400 ha (1,000 ac) of standing timber would have further enhanced the Okatibbee Lake sport fishery (Jack Herring, pers. comm., 1978). Also, improved water level management strategies could further benefit the lake's sport fishery, and continued communication and coordination of lake level manipulations should consider these options.

Much of the early pre-construction planning input for Okatibbee Lake related to the opportunity afforded by the project to alleviate the water pollution problems of the lower Okatibbee Creek area. The U.S. Public Health Service (with support of the FWS) sought additional storage in the Okatibbee project for dilution of these effluents. The construction agency modified the project so as to provide the additional storage, but two subsequent events seriously reduced these project-associated water quality benefits. The CE altered the water outlet structure design so that water is withdrawn from near the lake bottom. The decision to alter the tower design was not discussed with conservation agencies until after construction of the lake was completed. As a result of this design change, the waters released from the project during the summer months when the

lake thermally stratifies, potentially suffer serious oxygen deficiencies. Other chemical elements common to hypolimnia waters may be creating the oxygen sag noted in Okatibbee Creek downstream from the project. The second event largely negating the water quality improvement aspect of the Okatibbee project was a National policy change (1977) which denied use of dilution as a pollution abatement measure.

Although no major fish mortalities have resulted from the Okatibbee releases, the CE is aware of the potential for such events. A study is under way to evaluate alternative methods of improving the water quality of releases and a detailed design of the corrective measures will be developed upon completion of the study (3). Reallocation of reservoir storage initially intended for "pollution dilution" may provide an opportunity to manipulate the reservoir operation regime to benefit fish and/or wildlife resources.

The pre-construction FWS report recommended development of adequate access facilities in the vicinity of the tailrace. Such facilities have been provided by the construction agency.

## **SUMMARY**

The Okatibbee Lake project is located on Okatibbee Creek near Meridian, Mississippi. At summer seasonal pool the lake covers 1,538 ha (3,800 ac). Lands acquired in fee surrounding the summer pool totals 2,895 ha (7,155 ac). Approximately 2,024 ha (5,000 ac) have been licensed to the Mississippi Game and Fish Commission (MGFC) for the purpose of wildlife management.

These lake and land area dimensions were not those originally proposed by the construction agency for the Okatibbee project. A smaller project was proposed earlier with flood control and water supply as the only primary project purposes. The original engineering data were for a 1,133 ha (2,800 ac) water supply pool topped by an additional 1,902 ha (4,700 ac) flood pool. Acquisition in fee was planned to include only the area expected to be inundated by the five-year flood pool, approximately 2,428 ha (6,000 ac).

The FWS was requested to provide a professional appraisal of the fish and wildlife-related impacts of this smaller project at the Okatibbee site in 1961. The FWS was contacted by the CE and requested to return with their recommendations for fish and wildlife resources within three months (by August, 1961) so that the CE could more completely address the impacts of the proposed project on fish and wildlife in their survey report to Congress. The survey report was eventually submitted to Congress on December 29, 1961, some 14 days before release of the FWS's report which was dated January 12, 1962.

The 1962 report of the FWS contained two important fish and wildlife-related recommendations. The first was for acquisition and state management of additional land to allow mitigation of project-associated wildlife losses estimated to result in corresponding loss of 3,900 hunter-days of resource use. Acquisition of approximately 1,133 ha (2,800 ac) located above the five-year flood pool were proposed by the FWS for this purpose. Secondly, additional water storage to permit flow releases for dilution of downstream pollution, as had already been recommended by the Public Health Service, was supported as a project purpose by the FWS.

Two institutional changes occurred during the critical planning stages which allowed favorable consideration of both FWS recommendations by the construction agency. The Departments of the Army and the Interior signed an interagency agreement (February 22, 1962 Federal Register) allowing acquisition in fee of considerably more lands in association with water development projects (previously restricted to five-year flood pool). Also, passage of the Federal Water Pollution Control Act Amendments of 1961 authorized storage for flow augmentation.

As a consequence of these two new initiatives, the CE redesigned the Okatibbee project to include a seasonal (summer) water quality pool of  $1.6 \times 10^7 \text{ m}^3$  (12,900 ac ft) and the acquisition in fee of 4,433 ha (10,955 ac) of land and water.

These changes apparently proved satisfactory to the state and federal conservation agencies. In their updated fish and wildlife planning report (August 17, 1964), the FWS reiterated their earlier request to permit the

MGFC to manage selected project lands for wildlife purposes. They also recommended the development and implementation of a reservoir-use zoning plan, provision of access to the tailwater, and construction and operation of the project to meet the criterion for sustaining a desirable warm-water fish population. The criterion referred to was for a minimum dissolved oxygen concentration of 4.0 mg/l. The conservation agencies fully expected water of suitable quality to be provided in the downstream reach by the outlet works which were designed by the CE to withdraw water from no deeper than 4 m (13 ft). This discharge location was expected to be above any deoxygenated hypolimnetic waters that might develop in the deeper layers of Okatibbee Lake.

The MGFC had no comment regarding any part of the 1964 report of the FWS.

No quantitative projections of natural resource abundance or use of such resources were contained in the 1964 report of the FWS. The additional land planned for acquisition in fee was expected to mitigate the resources lost through habitat inundation, including the additional seasonal storage for water quality purposes, if such land were managed by the MGFC. Pre-impoundment conditions and predicted conditions with and without the project were quantitatively described in the 1962 report. These predictions were reaffirmed without elaboration in the 1964 report. Therefore, this evaluation has relied of necessity upon the earlier 1962 presentations compared with current conditions at the project for determination of the accuracy of fish and wildlife projections.

The 1962 report of the FWS treated a total impact area of 4,047 ha (10,000

ac) which closely approximates the actual 4,433 ha (10,955 ac) project land and water holdings. Realization of the pre-construction use levels, plus an additional four percent annual increase, was predicted for hunting on the 4,433 ha (10,955 ac) project site. This rate of increase was expected to result in an effort amounting to an average of 6,700 man-days per year over the 50-year period of evaluation. Recomputing the hunting effort on the same basis (increasing by four percent annually) for a point 10 years after impoundment (1968) provided a project-associated hunting use projection of 3,715 hunter-days for 1978. Current hunter-use statistics were available for comparison with these projections.

The hunting use projections for the project site were divided into small game, big game, and waterfowl components. The small game hunting projection of 2,500 hunter-days was almost identical to the current use level of 2,473 hunter-days. Data available from a mail survey of hunting in the 13-county Game Management Planning Unit 5, which includes the Okatibbee project, indicated that the squirrel and rabbit populations of the Okatibbee project could sustain twice as much effort and still provide relative success rates comparable to those reported by hunters from the larger Planning Unit.

The small land area associated with the Okatibbee project has restricted big game hunting, although the post-construction deer population on project lands is estimated at 100 to 120 head, which is equal to the pre-construction herd estimate. Only primitive weapons and archery hunting are allowed for deer. Hunting for turkey is prohibited on project lands. As a result, big game hunting currently supported by project lands (75 hun-

ter-days) is considerably below the level expected to have been provided by the present time (425 hunter-days). Project-associated deer and turkey populations may contribute to populations and harvest associated with lands peripheral to the Okatibbee project.

Waterfowl hunting effort (356 hunter-days) is slightly less than one-half the predicted level (790 hunter-days). Development of the project for waterfowl, which is the MGFC's primary management goal for the OWMA, has been handicapped by the inability to move heavy machinery into the management area to construct the levees necessary to create sub-impoundment habitat. Active beaver colonies, on the project's upper end, create marsh and swamp habitat which attracts migratory waterfowl. This habitat is performing, although in a less manageable fashion, the same functions which would have been provided by controlled sub-impoundments.

Alligators have been released in the swampy habitat on the upper end of the Okatibbee project. This successfully reproducing reptile population was established, in part, to control the beaver population. Waterfowl production on Okatibbee lands is probably double the total project-associated waterfowl harvest, although the only waterfowl being produced are wood ducks. This production is, in large measure, the result of an active program to erect nesting boxes. Waterfowl management has been handicapped by the water level regulation schedule for the project. The MGFC has requested that the summer seasonal pool be lowered earlier in the fall.

An earlier evacuation of the summer pool was carried out in 1973-74 to allow the application of fish control measures to reduce the gizzard shad

population of Okatibbee Lake. The necessity for such fish control remedy was accurately predicted in the 1962 report of the FWS. The predicted level of angler-use was reasonably close to the current estimate of actual use of the lake. Actual angling use of Okatibbee Lake was estimated at 40,600 annual trips, compared with the predicted 60,000 angler-trips.

It appears probable that the tailrace fishery supports approximately double the 7,000 angler-trips predicted prior to project construction. The lake fishery was expected to consist of largemouth bass, other sunfishes, and catfishes. The pre-construction planners did not anticipate the opportunities for diversification of the indigenous fishery through the introduction of non-native fish species. Striped bass have been successfully introduced in Okatibbee Lake.

Downstream water quality matters constituted significant portions of the pre-construction input by conservation and water quality agencies. The opportunity to ameliorate industrial pollution problems in the river below Okatibbee Lake was used to justify water storage at the project for this purpose. These expectations of post-impoundment water quality improvement were associated with the anticipated release of the additional water from the surface layers of the impounded lake. The CE, unilaterally, and without interagency coordination, altered the outlet tower design so that waters are released from near the lake bottom. Although Okatibbee Lake releases are not believed to have resulted in direct fish kills, the discharge is low in dissolved oxygen during periods of lake stratification; chemical constituents of the outflow are believed responsible for

oxygen sags observed downstream. The CE is currently studying means to alleviate downstream water quality problems associated with the operation of the Okatibbee project.

#### REFERENCES

1. Mobile District. 1970. Pascagoula River Basin reservoir regulation manual. Appendix A, Okatibbee Reservoir. Okatibbee Creek, Mississippi. Mobile, Alabama. April 1970.
2. Thoman, John R. 1969. Director, Southeast Region Federal Water Pollution Control Administration, Atlanta, Georgia, letter of October 22, 1969.
3. Mobile District. 1975. Final environmental statement Okatibbee Dam and Lake, Mississippi (flood control, water quality control, water supply and recreation). Mobile, Alabama. April 1975.
4. Towns, W. L. 1962. Letter-report on fish and wildlife resources in relation to the Okatibbee Creek project, Lauderdale and Kemper Counties, Mississippi. Atlanta Regional Office, U.S. Fish and Wildlife Service. January 12, 1962.
5. Mobile District. 1964. Okatibbee Dam, Design Memorandum No. 2, general design. Mobile, Alabama. July 17, 1964.
6. Gresh, Walter A. 1964. Detailed report of the effects on fish and wildlife resources of the Okatibbee Creek Reservoir project, Lauderdale and Kemper Counties, Mississippi. Atlanta Regional Office, U.S. Fish and Wildlife Service. August 17, 1964.
7. Annon. 1976. Initial follow-up report for Okatibbee Dam and Reservoir project, Mississippi. Decatur Field Office, Division of Ecological Services, U.S. Fish and Wildlife Service, Decatur, Alabama. February 1976.
8. Wiecking, E. H. 1960. Report on the panel on recreational values of the Subcommittee on Evaluation Standards (Inter-Agency Committee on Water Resources). May 24, 1960.
9. Holum, Kenneth. 1962. Assistant Secretary of the Interior, Washington, D.C., letter of July 6, 1962.
10. Udall, Stewart L. and Stephen Ailes. 1962. Joint policy of the Departments of the Interior and of the Army relative to reservoir project lands. Published in the 27 Federal Register 1734, February 22, 1962.
11. Camp, John P., Jr. 1964. Mississippi Game and Fish Commission, letter of August 6, 1964 to Fish and Wildlife Service, Atlanta, Georgia.

12. Hester, John M. 1965. Trip report, meeting on comprehensive studies on recreation and fish and wildlife. Submitted by Field Supervisor, Decatur, Alabama, to Regional Director, Atlanta, Georgia. Decatur, Field Office, U.S. Fish and Wildlife Service. March 30, 1965.
13. Carraway, Jim. 1965. Executive Director, Mississippi Game and Fish Commission, Jackson, Mississippi, letter of June 10, 1965.
14. Mobile District. 1965. Okatibbee Dam and Reservoir, real estate design memorandum no. 6, reservoir area. Mobile, Alabama. April 7, 1965.
15. Annon. No date. Management area plan for the period July 1, 1974-June 30, 1979 for Okatibbee Wildlife Management Area. Mississippi Game and Fish Commission, Game Division (Mimeo). Jackson, Mississippi.
16. Cross, Billy Joe. 1970. Annual management plan-Okatibbee Reservoir Wildlife Management Area for the year March 1, 1970 to February 28, 1971. Mississippi Game and Fish Commission. February 18, 1970.
17. Annon. No date. Okatibbee Waterfowl Management Area work plans for 1971-1972. Mississippi Game and Fish Commission.
18. Cliburn, Edsel. 1973. Mississippi Game and Fish Commission, letter of November 28, 1973 reporting on work year of July 1, 1972-June 30, 1973.
19. Phares, John H. 1974. Okatibbee Waterfowl Management Area work plans for the year July 1, 1973-June 30, 1974. Mississippi Game and Fish Commission, March 7, 1974.
20. Annon. No date. Okatibbee wildlife management work plan for 1974-1975. Mississippi Game and Fish Commission.
21. Cliburn, Edsel. 1975. Okatibbee Wildlife Management Area work plan for 1975-1976. Mississippi Game and Fish Commission, October 15, 1975.
22. Cotton, Dan. 1976. Okatibbee Wildlife Management Area work plan for 1976-1977. Mississippi Game and Fish Commission, August 6, 1976.
23. Annon. No date. Okatibbee Wildlife Management Area work plans for 1977-1978. Mississippi Game and Fish Commission.
24. Mobile District. 1974. Forest and wildlife management plan, appendix B and D to master plan for Okatibbee Lake, Okatibbee Creek, Mississippi. Mobile, Alabama. July 1974.

25. Hester, John M. 1978. Letter report on wildlife resource inventory for the Okatibbee Creek Basin. Decatur Field Office, U.S. Fish and Wildlife Service. May 22, 1978.
26. Guynn, David C., Jr., Harry A. Jacobson, Thomas M. Lowe, Edward J. Hackett. 1978. Mississippi mail survey of game harvest for 1976-77. Mississippi Game and Fish Commission. Pittman-Robertson Proj. W-48-25. Conducted in cooperation with Mississippi State University.
27. Cotton, William D., David D. Robinson and Billy J. Grantham. No date. Completion report 1966-1967 pollution studies on Chickasawhay River in Mississippi. Fisheries Division, Mississippi Game and Fish Commission.
28. Mobile District. 1974. Okatibbee Lake design memorandum, the master plan, appendix D, fish management plan. Mobile, Alabama. July 1974.
29. Smith, Billy Harold. 1973. Mississippi Game and Fish Commission, letter of December 6, 1973.
30. Smith, Billy Harold. 1974. Central Mississippi reservoir survey. Mississippi Game and Fish Commission. Dingell-Johnson project F-27-3, completion report. Jackson, Mississippi.
31. Williams, Doug. 1977. Central Mississippi reservoir survey. Mississippi Game and Fish Commission. Dingell-Johnson project F-36, completion report. Jackson, Mississippi.
32. Freeman, Barry O. 1978. Letter responding to Okatibbee Creek Basin discussion by U.S. Fish and Wildlife Service. Mississippi Game and Fish Commission, Jackson, Mississippi. May 22, 1978.
33. Mobile District. 1977. Environmental evaluation of releases from Okatibbee Lake. Mobile, Alabama. August 1977.